ROYAL ASTRONOMICAL SOCIETY.

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Dr. LEE, V.P., in the Chair.

William Markby, Esq., 2 Churchyard Court, Temple, was balloted for and duly elected a Fellow of the Society.

Elements of Comet II, 1858. By Dr. Winnecke.

(*Extract of a Letter from Prof. Argelander to the Astronomer Royal.*)

"Allow me to send you the accompanying elements which Dr. Winnecke has computed for his comet of short period. They are based upon his own observations of March 8, 12, April 6, and a Berlin Observation of March 28; and they give $+22''{\cdot}5$ and $4''{\cdot}6$ for the errors in latitude of the two extreme positions (Theor-Obs.).

"*Bonn, April* 12, 1858."

In a communication to the *Astronomische Nachrichten*, containing these elements, Dr. Winnecke remarks that they seem to indicate that between 1819 and 1858 the comet has accomplished eight revolutions.

Perihelion passage, 1858, May 2·52779, Berlin M.T.

$\pi - \Omega$	... ...	162° 58′ 59″·85
Ω	... ...	113 0 36·25
i	... ...	10 42 43·4
φ	... ...	47 35 5·2
Log a	... ...	0·466646
Log μ	... ...	2·850037

An ephemeris, extending from April 14 to May 8, which accompanied the above elements, was printed upon receipt, and copies of it forwarded to the principal observatories.

New Planet.

A new planet was discovered at the Observatory of Bilk, on the 4th of April, by Dr. Luther. It resembled a star of the eleventh magnitude. The following position of this new member of the solar system was obtained by the discoverer:—

1858, April 4, $12^h\ 32^m\ 13^s{\cdot}2$ M.T. Bilk.

	R.A.	Decl.
	° ′ ″	° ′ ″
	181 3 16·7	+5 30 31·2
Daily Motion	11″·1	+ 5″·5

This forms the fifty-third of the minor planet group.

Results of the Observations of Small Planets, made at the Royal Observatory, Greenwich, generally in the month of March, 1858.

(*Communicated by the Astronomer Royal.*)

Flora.

Mean Solar Time of Observation.		Apparent R.A.	Apparent N.P.D.
	h m s	h m s	° ′ ″
1858, Mar. 6	8 9 34·2	7 6 37·10	64 45 38·34
8	8 2 39·6	7 7 34·51	64 44 22·90
18	7 29 53·3	7 14 8·32	64 43 19·02

Melpomene.

Mean Solar Time of Observation.		Apparent R.A.	Apparent N.P.D.
	h m s	h m s	° ′ ″
1858, Mar. 9	13 7 57·7	12 17 39·30	84 2 26·72
11	12 58 25·7	12 15 58·81	83 44 6·55
22	12 5 28·4	12 6 14·90	82 5 21·89
23	12 0 38·9	12 5 21·19	81 56 52·91

Lutetia.

Mean Solar Time of Observation.		Apparent R.A.	Apparent N.P.D.
	h m s	h m s	° ′ ″
1858, Mar. 6	12 13 55·0	11 11 38·03	79 38 5·06
8	12 4 12·5	11 9 47·05	79 26 19·44
9	11 59 20·8	11 8 51·13	79 20 36·24
22	10 56 42·8	10 57 18·03	78 14 7·76

Eunomia.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1858, Mar. 5 11 9 13·4	10 2 49·25	91 0 58·08
8 10 54 54·4	10 0 17·56	90 50 7·95
9 10 50 9·5	9 59 28·41	90 46 25·20
11 10 40 43·3	9 57 53·83	90 39 2·48
22 9 50 8·7	9 50 32·98	89 58 3·59
23 9 45 40·6	9 50 0·68	89 54 25·83
26 9 32 24·1	9 48 31·63	89 43 55·29
29 9 19 20·2	9 47 15·29	89 33 59·52

Fortuna.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1858, Mar. 5 11 58 55·7	10 52 39·68	84 48 31·45
6 11 54 5·0	10 51 44·73	84 42 26·52
8 11 44 24·5	10 49 55·77	84 30 16·51
9 11 39 34·4	10 49 1·43	84 24 15·75
22 10 37 50·9	10 38 23·01	83 11 16·99
23 10 33 12·7	10 37 40·57	83 6 17·21
24 10 28 35·5	10 36 59·17	83 1 29·69
29 10 5 49·3	10 33 52·02	82 38 53·84

Thalia.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1858, Mar. 8 14 48 33·5	13 54 35·00	86 46 51·11
11 14 35 26·0	13 53 15·05	86 35 56·59
22 13 45 8·6	13 46 11·43	85 54 38·86
23 13 40 25·5	13 45 24·15	85 51 5·89
26 13 26 9·2	13 42 55·20	85 40 34·40
29 13 11 43·2	13 40 16·49	85 30 47·81

Themis.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1858, Mar. 6 7 46 55·7	6 43 54·87	65 55 13·01

Massilia.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1858, Mar. 22 14 18 56·0	14 20 4·44	104 2 29·33
23 14 14 27·1	14 19 31·36	103 59 28·40
26 14 0 51·8	14 17 43·47	103 49 30·70

Euterpe.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1858, Mar. 6 10 20 46·9	9 18 11·38	71 48 40·96
8 10 11 54·1	9 17 10·17	71 44 29·23
9 10 7 30·3	9 16 42·26	71 42 43·74
23 9 9 30·9	9 13 45·09	71 35 8·38
24 9 5 37·4	9 13 47·44	71 35 49·06
26 8 57 56·8	9 13 58·70	71 37 40·98
29 8 46 39·8	9 14 29·51	71 41 42·28

Amphitrite.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1858, Mar. 8 13 31 52·7	12 37 41·62	95 9 19·75
9 13 27 9·4	12 36 54·11	95 6 55.66
20 12 34 20·9	12 27 19·07	94 33 48·01
22 12 24 37·9	12 25 27·60	94 26 53·23
23 12 19 46·2	12 24 31·58	94 23 19·17
26 12 5 9·7	12 21 42·31	94 12 32·05
29 11 50 33·5	12 18 53·44	94 1 34·59

Europa.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1858, Feb. 24 12 14 41·8	10 32 59·44	75 41 10·04
25 12 10 0·7	10 32 14·12	... ...
Mar. 22 10 15 26·3	10 15 54·71	73 24 2·27
23 10 11 2·3	10 15 26·59	73 20 33·43
24 10 6 39·5	10 14 59·56	73 17 24·54
29 9 45 4·5	10 13 3·80	73 3 43·46

Extract of a Letter from Captain Jacob to Sir William Keith Murray.

"I can confirm your views of the colours of B and C of *γ Andromedæ*. I have never, indeed, seen them separate, but have long noticed that when the definition was best, the small end of the wedge was bluish and the other inclining to yellow."

Mr. Dawes informed Sir William Keith Murray some time ago that he had also observed the stars with his 8-inch American achromatic glass, and found the colours were blue and yellow.

On the Law of Contraction of the Nebulosity in Encke's Comet, as given by M. Arago. By S. M. Drach, Esq.

In Arago's work on the comet of 1832, ch. xi. (Gold's Translation, p. 55) occurs a table, copied in Smyth's *Celestial Cycle*, vol. i. p. 253. It gives the heliocentric distance r of Encke's comet and the corresponding true diameters $2a$ of the nebulosity in radii of the earth. I do not know if these values have been intercompared, but they vary nearly as the $+\frac{5}{2}$ power of r.

Date.	r	$2a$	$2a.r^{-\frac{5}{2}}$	$31{\cdot}38\,r^{\frac{5}{2}}$	$2{\cdot}152\,r^{-\frac{5}{2}}$
Oct. 28	1·4617	79·4	30·73	$2a + 1{\cdot}68$	+ 1·57
Nov. 7	1·3217	64·8	32·26	$2a - 1{\cdot}76$	+ 1·70
Nov. 30	0·9668	29·8	32·42	$2a - {\cdot}96$	+ 2·21
Dec. 7	0·8473	19·9	30·11	$2a + {\cdot}84$	+ 2·47
Dec. 14	0·7285	11·5	25·39	$2a + 2{\cdot}71$	+ 2·78
Dec. 24	0·5419	3·1	14·34	$2a + 3{\cdot}68$	+ 3·59

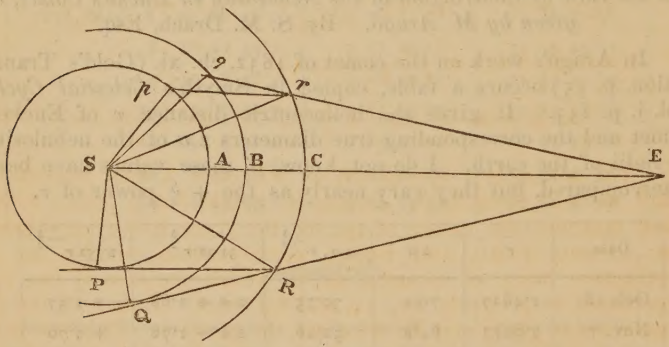
Mean of first 4 values = 31·38; general mean, 27·54. By adding the term $2{\cdot}152\,r^{-\frac{5}{2}}$, we obtain the secondary corrections, nearly agreeing with the 1st, 5th, and 6th observations.

15th January, 1858.

On the Evidence which the Observed Motions of the Solar Spots offer for the Existence of an Atmosphere surrounding the Sun. By R. C. Carrington, Esq.

The protuberances observed around the sun's periphery during total solar eclipses, and the excess of light and heat radiated from the centre of the disk as compared with the parts near the circumference, tend so strongly to force upon us the conviction of the existence of an atmosphere of no inconsiderable amount, that it is of some importance to inquire whether the motions of the spots, in passing over the disk, present any favourable or unfavourable indications.

The inquiry presents difficulties of two sorts, arising, firstly, from the little suitability of solar spots in general as data in any matter of delicacy, from their constant liability to change of form; and, secondly, from our entire ignorance of the law of density, which should be assumed for the supposed atmosphere under the peculiar conditions of temperature to which it must be subject. The first of these difficulties we must surmount as well as we can by selection of the spots for discussion: the second, I shall make free to evade on the present occasion by the old assumption of homogeneity, proposing only to inquire what sort of result will be yielded by that hypothesis, which in the case of the earth's atmosphere is well known to afford a close representation of the observed actual effects on a ray of light.



Let P Ap be a central section of the sun's actual photosphere by a plane passing through E, the centre of the earth. Let R C r be the corresponding section of the atmosphere, supposed homogeneous. Let S P $= r$; S R $= r\,(1 + h)$; refractive index $= m$. If a ray of light from the sun's actual limb reach the earth by the path P R E, it will appear to have come from the limb of a concentric sphere (the apparent photosphere), whose section is Q B q, and whose radius Q S $= m$. P S; since sin Q R S $= m$. sin P R S. A spot at p on the actual photosphere will appear in the direction E r q, or will be seen at q on the apparent photosphere, under an apparent angle B S q from the centre of the disk, instead of A S p the true. The position-angles of spots will be unaffected.

Let $\varrho = q$S E; $\quad \varrho' =$ S E $q = m$. (R). sin $(\varrho + \varrho')$

$= 16' \times \sin \varrho$, nearly

$$\sin \mathrm{S}\,r\,q = \frac{\mathrm{S}\,q}{\mathrm{S}\,r} \,.\, \sin \mathrm{S}\,q\,r = \frac{m}{1+h} \,.\, \sin(\varrho + \varrho')$$

$$\sin \mathrm{S}\,r\,p = \frac{1}{m} \quad . \quad \sin \mathrm{S}\,r\,q = \frac{1}{1+h} \,.\, \sin(\varrho + \varrho')$$

$$\sin \mathrm{S}\,p\,r = (1 + h) \,.\, \sin \mathrm{S}\,r\,p = \sin \mathrm{S}\,q\,r$$

$$\therefore\ p\,\mathrm{S}\,q = p\,r\,q; \quad \text{and } \mathrm{A\,S}\,p = \varrho + \mathrm{S}\,r\,q - \mathrm{S}\,r\,p.$$

Let A S p − ϱ be denoted by (ϱ)

$$(\varrho) = \sin^{-1}\frac{m}{1+h}\,.\,\sin(\varrho+\varrho') - \sin^{-1}\frac{1}{1+h}\,.\,\sin(\varrho+\varrho'). \qquad (1)$$

If m be but little greater than unity, this expression may be written with advantage in a different form.

$$\text{Let } a = \frac{m}{1+h}\,.\,\sin(\varrho+\varrho') = \frac{1}{1+h}\sin(\varrho+\varrho') + \frac{m-1}{1+h}\,.\,\sin(\varrho+\varrho')$$
$$= b + (m-1)\,.\,b$$

Since $\sin^{-1} a - \sin^{-1} b = \sin^{-1}(a\sqrt{1-b^2} - b\sqrt{1-a^2})$ we find, after some reductions, neglecting powers of $(m-1)$ above the second

$$(\varrho) = \sin^{-1}\,.\,\left\{(m-1)\,.\,\frac{b}{(1-b^2)^{\frac{1}{2}}} + \frac{1}{2}\,.\,(m-1)^2\,.\,\frac{b^3}{(1-b^2)^{\frac{3}{2}}}\,.\right\}$$

Accordingly if $\sin\tau = \frac{1}{1+h}\,.\,\sin(\varrho+\varrho')$

$$\sin(\varrho) = (m-1)\,.\,\tan\tau + \frac{1}{2}\,(m-1)^2\,.\,\tan^3\tau, \text{ very nearly.} \qquad (2)$$

The atmosphere speculated on will bear a bold assumption, and we will accordingly assume its height $h = \frac{1}{4}$. sun's radius, and compute the values of (ϱ) for the three following values of m... 1·005, 1·010, and 1·020; corresponding roughly to the refractive index of common air, of which the density has been increased respectively 17, 34, and 69 times. Either of the formulæ above given may be used for the purpose. The first is the more readily worked, and has been used in forming the following table.

TABLE I. $(h=\frac{1}{4})$.

ϱ	1·005	1·010	1·020	$10'\,.\,\frac{\tan\tau}{\sin\varrho}$
°	′	′	′	′
0	0·0	0·0	0·0	8·0
10	+2·4	+4·9	+9·7	8·1
20	4·9	9·8	19·6	8·3
30	7·5	15·0	30·2	8·7
40	10·3	20·7	41·5	9·3
50	13·4	26·9	53·9	10·1
60	16·7	33·4	67·0	11·1
70	19·8	39·6	79·8	12·1
80	22·2	44·4	89·6	13·0
90	+23·1	+46·2	+93·4	13·3

As a first series of observations for discussion, I have selected that of a small and well-defined spot observed in August and

September, 1854, under favourable circumstances, which in both its passages over the disk passed very near to the centre, and which, from August 8 to August 20, exhibited no marked deviation of its nucleus from a circular form. On its second appearance, it formed one of a small group; and after September 10 ceased to be distinguishable. In the table which follows are given in the first column the fractions of the days of observation (in civil reckoning), in the second and third p the angles of position and ϱ the angles from centre of apparent photosphere; in the fourth and fifth l and λ the heliographical longitudes (from node) and latitudes, deduced from the elements (for 1854·0) $N = 74^\circ\ 30'$, $I = 7^\circ\ 10'$, as adopted provisionally at Redhill.

From comparison of the longitudes of the two passages, at and about the dates at which the spot passed centre, it was found that $25^{d}\cdot240$ was the period of sidereal rotation for this spot. This value has accordingly been used in computing the dates in the sixth and last column, which are those of the spot's passing the meridian through node given by each day's observation.

1854.	p	ϱ	l	λ	t
	° ′	° ′	° ′	° ′	d
Aug. 8·525	98 23	77 48	162 30	N 6 32	22·372
10·504	101 8	51 43	190 43	6 33	·374
11·537	102 40	37 54	205 39	6 25	·359
13·525	107 19	11 35	234 4	6 3	·354
14·494	265 46	1 16	247 51	6 9	·357
16·574	286 27	28 27	277 16	5 48	·374
18·600	289 41	55 16	306 15	5 50	·369
19·470	290 58	66 30	318 25	5 50	·385
20·502	292 33	79 41	333 44	5 49	·344
Sept. 4·525	107 44	77 52	188 40	N 5 39	22·297
6·519	110 31	52 30	216 11	5 54	·362
7·513	111 43	39 34	230 11	6 8	·374
10·531	244 43	0 45	273 28	6 36	·358

As the parallel on which this spot was situated passed nearly through the centre of the disk, and its latitude was small, the differences of heliographical longitude of the spot and the centre of the sun's disk were on each day nearly equal to ϱ, and were amenable to sensibly the same corrections for solar refraction. The heliographical longitudes will accordingly receive the same corrections, and the times t the equivalents in time with opposite signs. Taking $t =$ Aug. 22·365 as the concluded mean, the next table exhibits first the uncorrected discordances of t; and next, these discordances corrected on the three suppositions indicated.

Disc^s.	$m=1{\cdot}0025$		$m=1{\cdot}0050$		$m=1{\cdot}0100$	
d	d	d	d	d	d	d
+·007	+·012	+·019	+·025	+·032	+·050	+·057
+·009	+·008	+·017	+·016	+·025	+·033	+·042
+·006	+·006	·000	+·012	+·006	+·024	+·018
−·011	+·002	−·009	+·004	−·007	+·007	−·004
−·008	−·000	−·008	−·000	−·008	−·001	−·009
+·009	−·004	+·005	−·008	+·001	−·016	−·007
+·004	−·009	−·005	−·017	−·013	−·035	−·031
+·020	−·011	+·009	−·022	−·002	−·045	−·025
−·021	−·013	−·034	−·026	−·047	−·052	−·073
−·068	+·012	−·056	+·025	−·043	+·050	−·018
−·003	+·008	+·005	+·017	+·014	+·033	+·030
+·009	+·006	+·015	+·012	+·021	+·025	+·034
−·007	−·000	−·007	−·000	−·007	−·000	−·007
±·182		±·189		±·226		±·355

The first hypothesis leaves the resulting sum of discordances much as it was before correction, but the second and third sensibly increase it, in other words, do harm instead of good. The sums on the three hypotheses, however, indicate that a smaller value of m would probably give a better result. Treating the discordances by equations of condition and the method of least squares, we find $m = 1{\cdot}002003$ as the most probable value, the sum of the discordances being in that case reduced to ± 176. The observations accordingly afford very slender evidence *in favour* of an atmosphere for which $h = \frac{1}{4}$, $m = 1{\cdot}0020$, but will not bear one for which m much exceeds $1{\cdot}005$.

We will now take a different case, in which no assumption of elements of the plane of rotation need be made. If two spots are passing over the disk together, and solar refraction be insensible, the distance between their centres in arc of a great circle should be constant from day to day, or affected only by the independent motion of the spots. On the other hand, if the observed angles are affected by refraction, the mutual distance will appear to vary. The independent motions of spots being notoriously less in latitude than in longitude, whether arising from change of form or translation, it appears at first sight best to select a pair not differing much in longitude, and differing widely in latitude. I find such a series recorded in my books for June 22, 1854, and the five subsequent days, after which the southern spot underwent such a change of form as renders the remaining positions unfit for our present purpose.

If ϱ_1, ϱ_2, be the observed distances from centre, and p_1, p_2, the

observed position-angles, the mutual distances φ result from the well-known expression

$$\cos\varphi = \cos\varrho_1 \cdot \cos\varrho_2 + \sin\varrho_1 \cdot \sin\varrho_2 \cdot \cos(p_1 - p_2).$$

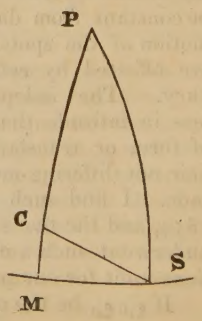
The following table gives these observed and computed angles, uncorrected for solar refraction.

1854.	ϱ_1	ϱ_2	$p_1 - p_2$	φ	Discs.
	° ′	° ′	° ′	° ′	′
June 22	54 20	67 42	28 5	27 49	− 3
23	42 2	55 46	32 18	27 39	−13
24	29 20	43 37	41 26	27 49	− 3
25	16 51	32 14	62 38	28 17	+25
26	8 13	22 24	125 35	27 57	+ 5
27	13 52	17 17	125 20	27 39	−13

The next table gives the same angles corrected for solar refraction on the hypothesis $h = \frac{1}{4}$, $m = 1{\cdot}010$.

1854.	ϱ_1	ϱ_2	$p_1 - p_2$	φ	Discs.
	° ′	° ′	° ′	° ′	′
June 22	54 50	68 20	28 5	28 0	− 4
23	42 24	56 17	32 18	27 52	−12
24	29 35	44 0	41 26	28 2	− 2
25	16 59	32 30	62 38	28 31	+27
26	8 17	22 35	125 35	28 10	+ 6
27	13 59	17 25	125 20	27 52	−12

On comparing the individual discordances in the two tables we here perceive that correction for refraction affects the angles φ by an almost constant amount, and that, consequently, the case taken for discussion is less suitable than it appeared at first sight, and is, in fact, of little or no use for the purpose. Still I have retained it in this paper, from its informing us of one important circumstance, that the latitudes of spots receive nearly constant corrections for solar refraction, and consequently that elements of the plane of the sun's rotation deduced from uncorrected angles will be sensibly unaffected with error.



Let us see how this arises. If P be the sun's pole, C the apparent centre of the disk S a spot, S M its parallel, C S = ϱ

$$d\lambda = (\varrho).\ \sin \mathrm{CSM} = \frac{m-1}{\sin 1''}.\ \tan \tau.\ \frac{\sin \mathrm{C\,M}}{\sin \varrho},\ \text{nearly};$$

$$\text{or } d\lambda \text{ varies nearly as } \frac{\tan \tau}{\sin \varrho};\quad \text{since C M is constant.}$$

I have given the values of this ratio for convenience in the last column of Table I. for $h = \frac{1}{4}$, by which it appears that they may be considered constant in connexion with the unavoidable errors of observation, and absolutely vary very slowly for most values of ϱ.

We are compelled to recur again to longitudes. If a pair of well-defined spots could be found differing little in latitude and about 30° in longitude, which had twice crossed the disk together under favourable circumstances of observation, I should select them for our next discussion; but the conditions are such as are not satisfied by any series I have yet succeeded in obtaining.

Accordingly that the conclusions of this paper may not rest on a single series of observations, although satisfactory in themselves, I will, lastly, take another series of deduced longitudes for examination, which were obtained at nearly the same time in the same year 1854. During its first passage, the spot exhibited a circular and well-defined nucleus, which appeared to attain its greatest actual expansion about the time it first passed the centre. At its reappearance, all trace of penumbra was gone, the nucleus was much reduced, and was an exceedingly sharp object for observation. After Sept. 1 it was no longer to be seen.

1854.	p	ϱ	l	λ	t
	° ′	° ′	° ′	° ′	d
July 29·565	114 45	68 28	164 42	S. 11 40	12·268
30·518	118 12	56 2	178 37	11 30	·234
Aug. 1·496	133 17	31 53	207 2	11 12	·221
2·555	153 25	21 37	221 46	11 8	·251
6·586	259 47	43 6	278 46	10 56	·281
7·517	265 31	54 35	292 3	10 42	·281
8·525	269 29	66 32	305 34	10 26	·341
Aug. 25·508	123 2	69 47	189 24	S. 10 14	12·229
26·535	126 44	57 24	203 23	10 20	·276
27·564	132 9	44 25	218 10	10 3	·268
28·528	141 24	33 5	231 56	10 13	·267
29·526	159 58	22 55	246 19	10 23	·256
30·522	195 9	17 34	260 29	10 23	·259
31·546	235 23	21 5	275 6	10 19	·258
Sept. 1·517	256 34	30 5	288 54	S. 10 8	12·262

The period $25^{d}\cdot240$ for the sun's sidereal rotation satisfies best the above longitudes, and has been used, as in the first example, in computing the dates t. In the first column of the next table are given the quantities (ϱ); in the second, the corrections to l on hypothesis $m = 1\cdot010$, computed by a fresh reduction with the same elements used before; in the third, the uncorrected discordances of t; in the remainder as indicated.

(ϱ)	dl	Disc^{a}.	$m = 1\cdot0025$		$m = 1\cdot0050$		$m = 0\cdot0100$	
′	′	d	d	d	d	d	d	d
+38	+38	+·004	+·011	+·015	+·022	+·026	+·045	+·049
+32	+32	−·030	+·010	−·020	+·019	−·011	+·038	+·008
+16	+14	−·043	+·004	−·039	+·008	−·035	+·016	−·027
+11	+ 7	−·013	+·002	−·011	+·004	−·009	+·008	−·005
+22	−21	+·017	−·006	+·011	−·012	+·005	−·025	−·008
+30	−29	+·017	−·009	+·008	−·017	·000	−·034	−·017
+37	−37	+·077	−·011	+·066	−·022	+·055	−·043	+·034
+40	+40	−·035	+·012	−·023	+·023	−·012	+·047	+·012
+32	+32	+·012	+·010	+·022	+·019	+·031	+·038	+·050
+23	+22	+·004	+·007	+·011	+·013	+·017	+·026	+·030
+17	+15	+·003	+·004	+·007	+·009	+·012	+·018	+·021
+11	+ 7	−·008	+·002	−·006	+·004	−·004	+·008	·000
+ 8	− 3	−·005	−·001	−·006	−·001	−·006	−·003	−·008
+10	− 7	−·006	−·002	−·008	−·004	−·010	−·008	−·014
+15	−13	−·002	−·004	−·006	−·007	−·009	−·015	−·017
Sums: 1st Series		±·201		±·170		±·141		±·148
— 2d Series		±·075		±·089		±·101		±·152
— Both		±·276		±·259		±·242		±·300

The discordances of the first series are larger than those of the second, as was to be expected from the spot being of greater size, and offering a less definite centre for observation. It will be necessary to have regard to this circumstance in considering the uncorrected and corrected sums. The first hypothesis on the whole improves the result; the second, while it diminishes the total, sensibly increases the sum of the second series; and the third, judging principally by the second series, shows decided signs of over-correction. If we now treat the discordances as before by equations of condition, the method of least squares gives by the first series $m = 1\cdot008176$, and by the second, which is to be preferred, $m = 1\cdot001998$; by the whole $m = 1\cdot005684$. If we hold by the evidence of the second series, we have $1\cdot0020$ as the

most probable value of m, precisely the same which resulted from our former discussion. If it be thought better to include the first series, we find a somewhat larger value. As a general conclusion we may say that the motions of the solar spots in longitude will be more nearly proportional to the time, if we apply corrections to the angles ϱ differing little from half of those in the first column of our Table I; that their evidence is on the whole in favour of an atmosphere causing refractions of about half the amount there tabulated, but is opposed to refractions much exceeding those in amount.

As a definitive result, the conclusion will probably be considered as entitled to little weight; yet it is such as would agree pretty well with the idea that the red protuberances are cloudy masses of great tenuity held in suspension, as well as with the absorptive action on light and heat, which has been previously noticed by observers.

It is at least satisfactory to find that the motions of the spots offer no objections to the admissibility of an atmosphere, such as common air of a uniform density increased from 8 to 10 times, and extending to a distance from the surface equal to one-fourth the radius, but rather favour the assumption of an equivalent atmosphere, while they suffice to assign quickly a superior limit to its amount.

The observations discussed, not having been corrected for terrestrial refraction, it is desirable to point out that the angles ϱ are sensibly independent of correction from that source, being derived from the expression

$$\frac{r}{R} = \sin(\varrho + \varrho')$$

where r and R are respectively the linear distances of spot and limb from centre of disk, which, as is well known, are by refraction contracted in very nearly the same proportion. (See the example given in the *Monthly Notices* for March 1854.)

The principal source of error which may affect our result is the omission of the effect of perspective on the apparent centre of a spot's nucleus, accordingly as we adopt the conclusions of Dr. Wilson, or Sir W. Herschel, on that subject. But if we exclude observations very near the limb, and take only spots which exhibit penumbra on the side next the centre, our conclusions will not be affected by Dr. Wilson's hypothesis; excepting, it is true, that the radius of the disk employed should be diminished by the depth of the spot's cavity. On Sir W. Herschel's hypothesis (the word is perhaps objectionable), it would similarly be necessary to diminish the radius employed by the distance between the surfaces of the photosphere and the cloudy stratum. But if a spot be taken, as in the second series of our second spot, which exhibits no penumbra, no such objection will lie. The remaining difficulty is inherent, the little permanence of such spots.

On Col. James's Geometrical Projection of the Sphere and on the Stereographic Projection.

The Astronomer Royal exhibited an engraved map or "Geometrical Projection of two-thirds of the Sphere" by Colonel James, and accompanied it with the following remarks:—

Lieut.-Col. H. James, Director of the Ordnance Survey of Great Britain, has lately circulated copies of a map exhibiting considerably more than the terrestrial hemisphere: embracing, in fact, about 225° of meridian.

To the best of my knowledge, this is the first instance in which such an extent has been given to a map. The effect, on looking at the whole, is rather puzzling to the eye. The idea of perspective view of a globe is soon lost; and it looks rather like Mr. Wyld's great concave globe, with the forms of countries exhibited as viewed from the interior, but nevertheless turned with regard to right and left as viewed from the exterior. On looking at limited districts, even of large extent, all confusion ceases, and great advantage is found in the comparative freedom from interruption by the boundaries of the map. The plan, on the whole, is very convenient. The centre of Col. James's map is in latitude 23° 30′ north, longitude 15° east: and the map then includes nearly all the habitable parts of the earth except Australia. A small supplementary map contains Australia, New Guinea, New Zealand, and neighbouring islands.

It appears from the marginal explanation that the map is a truly geometrical projection upon a plane, the point to which the straight lines of projection converge being exterior to the surface of the sphere by a quantity equal to half the radius of the sphere, and the plane of projection being at right angles to the line joining this point with the centre of the sphere.

Many years ago, I amused myself (rather with a geometrical than with a geographical view) with drawing maps on the stereographic projection (or that in which the point of projection is in the surface of the sphere), embracing more than the hemisphere. The sight of Col. James's map recalled these speculations to my mind, and I thought it desirable to draw a stereographic map of nearly the same extent as Col. James's, with the view of comparing the distortions and the departure from uniformity of proportions of areas in different parts of the same map. I need not point out that maps of this extravagantly large extent are well adapted to exhibit to the eye those faults or peculiarities which must to some extent accompany every representation of a spherical surface upon a plane.

I have accordingly prepared a small manuscript map on the stereographic projection, which I beg leave to exhibit to the members of the Society. Its central point is in latitude 25° north, longitude 15° east; and it includes 230° of meridian.

A few words of notice will suffice for indicating to the Society the characteristic differences between the two maps.

It is well known that the peculiar character of the stereographic projection (in which it is followed by that remarkably artificial device, the Mercator's Chart) consists in this; that, considering only a small district, there is no distortion. A circle is always represented as a circle; a small square, in whatever position, is represented as a square; and, generally, a limited district is faithfully represented in its proper form.

In Colonel James's projection there is considerable distortion near the limits of the map. A square, whose sides are parallel to the boundary, is converted into a rectangle whose length is double its breadth; if its angle is presented to the boundary, it becomes a lozenge of which one diagonal is double the other; a circle is converted into an ellipse of which the major axis is double the minor. The injurious effect of this is seen in the depiction of California, of Japan, and of the islands beyond Borneo, which are very much squeezed up in the direction perpendicular to the boundary of the map. The same tracts are represented in the stereographic map with their proper forms. On the other hand, the amount of superficies upon the map corresponding to a given small superficial extent upon the earth varies considerably in different parts of the maps; and the variation is greater in the stereographic projection than in Colonel James's. The proportion of surface occupied by a square degree at the centre of the map to that occupied by a square degree at the edge of the map is in the stereographic projection as 1 to 5 nearly, in Colonel James's as 1 to 2 nearly. Thus in the stereographic map it will be seen that Africa is sensibly too small as compared with North America; and in a greater degree than in Colonel James's map.

Between these two evils the election must be made. A map may easily be made, exhibiting surfaces in accurate proportion, but with great distortion; or a map may be made (the stereographic) without distortion, but with inaccuracy of proportion of surfaces. But no map can be made free from both errors.

Of the two forms, I prefer the stereographic. It is seldom that, in inspecting a map, we desire to compare the areas of tracts 100° or 120° apart; but we almost always desire to see in its proper form the limited tract which we are viewing. And the geometrical meridians and parallels furnish the eye with a scale of which it instantly and without effort avails itself. I do not suppose, however, that these reasons will present themselves with equal force to every one's mind.

For the convenience of those who may desire to draw a map on the stereographic projection, I will here set down the necessary formulæ. It must be premised that, whatever point is adopted as the centre of the map, *every* meridian and *every* parallel will be represented by a circle or part of a circle (becoming in two special instances a straight line): there will be no ellipse or other curve. It may also be remarked that the boundary of the map is not

necessarily circular; although, in conformity with custom, I shall in one formula suppose it to be circular.

Let the centre of the map be in north latitude α, and let the radius of the map in degrees, or half the length of the meridian to be included in the map, be β. Also let a be the linear radius of the circle which would include the projection of an exact hemisphere.

1. The radius of the whole map will be $a \tan \frac{\beta}{2}$.

2. Draw through the central point a straight line for the polar axis. The centres of all the parallels of latitude will lie on this line.

3. For the parallel of north latitude x, the two intersections of the circle with the polar axis will be north of the central point by $a \tan \frac{x-\alpha}{2}$ and $a \tan \frac{180^\circ - x - \alpha}{2}$ respectively. The centre of the circle will be north of the central point by half the sum of these quantities, or by $\frac{a}{2}\left\{\tan \frac{x-\alpha}{2} + \tan \frac{180^\circ - x - \alpha}{2}\right\}$. The strictest attention must be given to the algebraical signs.

4. The north pole is north of the central point by

$$\frac{a}{2}\left\{\tan \frac{90^\circ - \alpha}{2} + \tan \frac{90^\circ - \alpha}{2}\right\} = a \tan \frac{90^\circ - \alpha}{2}.$$

The south pole is north of the central point by

$$\frac{a}{2}\left\{\tan \frac{-90^\circ - \alpha}{2} + \tan \frac{270^\circ - \alpha}{2}\right\} = -a \tan \frac{90^\circ + \alpha}{2},$$

or is south of the central point by $a \tan \frac{90^\circ + \alpha}{2} = a \operatorname{cotan} \frac{90^\circ - \alpha}{2}$.

5. The fundamental line for meridians, on which the centres of all the meridians will lie, will be a straight line at right angles to the polar axis, but *not* passing through the central point. It will be the straight line which represents the parallel of latitude for latitude $-\alpha$ north, or latitude α south; its distance from the central point will be $-a \tan \alpha$ north, or $a \tan \alpha$ south; it bisects the space between the two poles.

6. The meridian whose longitude is east of the central point by y will intersect this line at the two points whose distances east of the polar axis are a secant $\alpha \times \tan \frac{y}{2}$ and a secant $\alpha \times \tan \frac{180 + y}{2}$, or which are respectively $a \sec \alpha \times \tan \frac{y}{2}$ east and $a \sec \alpha \times \cot \frac{y}{2}$ west. The distance of the centre of the circle from the polar axis will be $\frac{a}{2} \sec \alpha \left\{\tan \frac{y}{2} + \tan \frac{180^\circ + y}{2}\right\}$ east, or $a \sec \alpha \times \operatorname{cotan} y$, west.

These are all the formulæ required for the stereographic projection in the most general case.

Observations of the Annular Solar Eclipse of March 14–15, 1858.

Observed at Bath, by C. H. Weston, Esq.

The sky which had been clear in the early part of the morning began afterwards to exhibit a greasy character, and became cloudy at the commencement of the eclipse, so that only a hasty and useless view of the first contact could be obtained. Subsequently the clouds lost their cumulus and assumed a misty form, until a widely-spread misty cloud covered the upper regions. These continuous misty clouds evidently resulted from the constant impinging of the under portion of the higher and colder current (then blowing from about the N.N.E.) upon the upper part of the warmer lower current from the W.N.W., and this state of things lasted until after the eclipse.

The only observations which I have to make must therefore bear rather upon the temperature and weight of the atmosphere. During the eclipse I used two thermometers whose range previous experiments had proved to coincide very accurately. The bulb of one was *blackened*, while the other was left untouched. The former had a south aspect, and the latter a northern. Their ranges were respectively as follows:

Black Bulb.		White Bulb.	
h m	o	h m	o
11 32	56·5	11 34	48·5
37	56·25	38	48·5
50	52·75	50	48·0
12 15	51·0	12 17	47·25
30	50·0	27	46·66
36	49·75	...	...
46	48·75	50	46·25
1 0	48·75	1 0	46·0
20	48·0	20	45·5
37	48·0	33	45·75
45	48·25	47	46·0
2 11	50·5	2 13	47·0

My barometer stood thus:

20^{m} before the first contact	29·182	
Greatest obscuration	29·116	Depression ·066
20^{m} after the last contact	29·192	

The diminution of light during the greatest obscuration may have caused a little error in reading off, but not in the least to affect the great fact of its lowest depression at that time. I should also state that I have not corrected the heights of the column of mercury for the sea-level, because the position of my residence (not far from 500 feet above the sea-level) does not touch the *relative* values of those heights.

On examining the above tables we find,

1. That from the commencement of the eclipse, the temperature of the atmosphere (correctly given by the white bulb thermometer with a northern aspect) regularly decreased to the period of greatest obscuration.

2. That the black bulb thermometer with a southern aspect (which had reference to the sun's radiating power) decreased in a similar ratio.

3. That the barometer showed analogous variation.

It is, indeed, observable from the thermometer-tables that the greatest depressions were not strictly coincident with the greatest obscuration of the sun. This circumstance, however, is not only what might *à priori* have been reasonably expected, but what also has actually been observed in a former solar eclipse.

I will only add that the atmosphere assumed during the greatest darkness a lurid character, and towards the distant horizon it passed from an olive to a yellowish tint, or rather olive-yellowish tint. The first range of hills stood out in black relief, but the more distant were misty. Rooks, which pass our house daily and return in the evening, now flew home during the obscuration, and one neighbour heard the cock crow, as the light beginning to return gave the appearance of a second dawn.

Bath, Sion Place, March 19.

Observed at Calne, Wiltshire, by W. and J. Simms, Esqs.

In the hope of seeing the annular phase of the solar eclipse on the 15th of this month, we went to Calne, in Wiltshire, one of the places according to the Ordnance Map through which the central line of the eclipse would pass.

Our telescopes were of 30 inches focal length, with magnifying powers of 46 and 72 times respectively, we had also other eye-pieces of sufficiently low power to show a considerable margin round the entire disk of the sun. We likewise carried with us an aneroid, of the correct action of which we had previously satisfied ourselves, and three thermometers graduated to Fahrenheit's scale.

At the commencement of the eclipse the sun was seen through a thin film of cloud, and was generally visible with a greater or less degree of brilliancy, until about three-fourths were eclipsed.

The moon's edge, which we saw very distinctly and free from undulations, exhibited great irregularities, and at one part in particular a mountain was observed, the summit of which was much above the general edge; on one side it rose at a moderate angle, and on the other abruptly from a considerable depression.

The sun shone out brightly during the occultation of a large group of spots, which were surrounded by extensive penumbræ. The spots retained their forms and their sharpness of outline perfectly unchanged, even to contact with the moon's edge, so far, however, as our optical means enabled us to judge.

As the eclipse advanced, the sun became obscured by clouds, the landscape gradually, but almost imperceptibly, darkened until about five minutes before the formation of the annulus, when the increase of the gloom became more and more apparent every second.

At this time a number of lambs, which had been at play in a meadow before us, suddenly gave up their sport, and crowded closely together with their dams.

The extreme darkness lasted very few seconds, perhaps not exceeding four, and the return of a considerable degree of light was instantaneous. During the greatest darkness which came, not as evening approaches, but suddenly and palpably, we took especial notice of the landscape. The extreme distance had assumed a deep purple hue, vapour had condensed and was suspended over the valley, objects near to us were singularly dark, but nevertheless perfectly well defined, whilst the relative distance of all objects appeared quite unchanged.

The clouds quickly passed away, and at $1^h\ 5^m$ we saw the narrow crescent of light, too late, however, to afford us the smallest gratification.

During the eclipse the barometer fell from 29·928 to 29·903. At $1^h\ 5^m$ it had risen to 29·920, but continued to fall subsequently. The temperature by a thermometer exposed to the sun was at the beginning of the eclipse 57°·9, and at $12^h\ 55^m$ it was 50°·5. The temperature in the shade was 54°·0 at the beginning of the eclipse, and at $12^h\ 55^m$ it was 50°·2. At $1^h\ 5^m$ it was 50°·8, which was the last observation we made.

138 *Fleet Street, March* 24.

Observed at Somerton, Oxford, by J. Slatter, Esq.

Place of Observation.—The site chosen was a piece of high ground above the village of Somerton, in the county of Oxford, on the site of the old hall, about 450 feet above the level of the sea, as determined by comparison with the barometer observations at the Radcliffe Observatory, and half a mile north of the central track of the eclipse.

Telescope Observations.—Scarce any use could be made of the telescope. The sun was visible only three or four times by glimpses during the progress of the eclipse.

Observations for Temperature and Humidity.—The thermometers used were a wet-and-dry bulb by Barrow, hung on the northern face of the wall, at the distance of a few inches from it; and a similar pair by Newman, of which the dry bulb was blackened and exposed in the telescope stand facing the south. The bulb was quite open at $11^h\ 45^m$ A.M. It showed a temperature of 51°·3, which declined to 48°·0 at the time of the height of the eclipse, after which it rose to 51° at $2^h\ 15^m$ P.M. The readings of the wet bulb show a decided, though slight increase of humidity

immediately following the centre of the eclipse; but the clouded state of the sun and the nature of the weather prevented this from being a remarkable feature.

General Observations.—At $0^h\ 10^m$, Oxford mean time, the light was that of a dull November day.

At $0^h\ 45^m$, light sensibly diminished, but still considerable; flame of lamp much brighter: daylight estimated equal to half what it was ten minutes ago.

I now endeavoured to gain some definite estimate of the amount of light by shadows cast from the lamp. The result of these is given below.

From $0^h\ 50^m$, the light rapidly decreased till $0^h\ 54^m$, which was the commencement of the darkest phase. The light certainly began to return again within 30^s, probably 20^s; so that the time estimated as the centre of the eclipse will, all corrections duly allowed for, be $0^h\ 59^m\ 7^s$, G.M.T.

The most noticeable fact, however, was that, whilst the darkness came on very gradually, the return to daylight was apparently sudden. I am inclined to attribute this to physiological causes connected with the eye. The darkness comes on whilst the iris is contracted. As the light wanes, the iris distends; and the returning light, falling on a fully dilated pupil, affects the eye more strongly than the same amount of light did previously to the darkness.

The dark phase was plainly to be distinguished from that which went before and followed.

Measures of the Light at the Height of the Eclipse.—1. At $1\frac{1}{2}$ minute before the time of greatest obscuration, I held a foot-rule to the glass of the lantern. I found that at 12 inches distance the sunlight was still so strong that the lantern cast no circle of light on the paper held parallel to the glass. It was, however, perceptible at a distance of 9 inches. Whilst my pencil, held before it, cast a shadow at no greater distance than one inch.

2. At the time of the greatest darkness the lantern cast a very perceptible light, and the shadow was made at a distance of 8 inches from the paper.

3. One minute later, when the darkest phase had passed about 30^s, all things being as before, a shadow was obtained at a distance of 3 inches from the paper.

The same evening being cloudy, though the clouds were not so dense as during the eclipse at $6^h\ 4^m$ P.M., the light was less than at the time of the first experiment, and about equal to that which marked the third trial; whilst at 9^m past 6, I obtained the same shadows as during the height of the eclipse.* At this

* These trials were made in a large window facing the south, upon a table pushed up within a foot of it; the lantern being recessed behind the curtain; as it was during the eclipse in a hole of the wall. In both cases the full light from the southern sky was allowed to shine freely at right angles to the cone of rays from the lamp.

time the sun's centre was 1° 35′ below the horizon. I had found no difficulty in writing down my observations during the period of greatest darkness. The same evening I was obliged to light my candle to write on at $6^h\ 24^m$, P.M.; at that time the sun was 3° 55′ below the horizon.

Rose Hill, Oxford, March 15, 1858.

Observed at Edinburgh and Brentwood, by Prof. C. P. Smyth and his Assistants.

(1.) Having prepared, through the assistants of the Edinburgh Observatory and myself, to occupy a station in England (Brentwood, in Essex), as well as that on the Calton Hill, I have a few remarks to offer on what was seen at either place, though clouds prevented anything important being instrumentally observed.

Observations.

(2.) At Edinburgh little was seen except for a short time about $0^h\ 15^m$ P.M. Then the 6-inch equatoreal in its dome converted into a camera, threw an optical image of the sun, some 4 inches in diameter, on a white screen, with the moon's edge transiting over a fine group of spots. This edge had no proper serration or protuberance; but, equally with the sun's limb, was boiling, and broken into numerous undulations, travelling, as it were, along most industriously; and presenting the usual appearance of the border of the sun when looked at with a high magnifying power in a tremulous atmosphere.

(3.) The mural circle thermometer, in its usual position, well protected from radiation of all sorts, gave the following readings at the undermentioned times:—

h m	Fahr. °	h m	Fahr. °
11 45	46·1	1 5	45·9
0 0	46·0	1 20	45·9
0 15	46·1	1 35	45·8
0 30	46·2	1 50	45·9
1 0	45·9	2 5	46·0

(4.) At Brentwood all the middle part of the eclipse was seen by the naked eye, though through driving clouds, nimbi and cirrostrati, the whole of the time. The effect of a dense part of the cloud in decreasing irradiation, and of a rare part in increasing it, was very remarkable, the solar crescent being made alternately thin and thick.

(5.) When the eclipse was at its maximum, and the sun reduced to so thin a line (estimated at its centre to be 30″ in diameter), that a bystander involuntarily exclaimed, "Why it's going to be a total eclipse," there was nothing like darkness, only a gloom, and which hardly decreased the visibility, partly, perhaps, because it improved the definition, of distant things.

(6.) Almost immediately after the exclamation mentioned

above, I perceived a strange fluctuation of the light in the region of illumined cloud which kept constantly about the sun in a patch about a degree to a degree and a half broad, notwithstanding the rapid passage of the semi-transparent clouds across. I was not at the moment thinking of the "flickering lights" seen near the totality of former eclipses, but the appearance instantly brought them to mind; and I called attention twice, at an interval of some five or seven seconds, to what seemed to me the startling coming forward and going back of the light of the solar crescent and the illumined mist round about it. The clouds dimmed the sun too much to permit me to see any shadows of things close at hand, and I had for the same reason some time before given up the attempt to look for crescent images in the shade of a large laurel-tree; I speak, therefore, only of what I saw looking direct at the sun with the naked eye. The circumstances of observation were evidently bad to detect anything cosmical in the nature of the light coming from the narrow uneclipsed solar crescent; but the manifestation which took place was so very different from anything that had appeared up to that moment, and from anything immediately dependent on the transverse motion of the clouds, that I was startled to a degree.

(7.) When still almost transfixed with astonishment at the pulsations of light from the luminous solar region, the line of cusps began visibly to alter. Though prepared for the computed rate of motion, I was unprepared to realise to the feelings such rapidity of change in any celestial things as then followed; it was more like a steering-wheel going round in the hand of a strong sailor, than any of the proper motions ever witnessed in the sky by men; and it seemed at the same time to be the very *ne plus ultra* of astronomical signals for small differences of longitude, from the vastness of the measurable change in a second of time.

Conclusions.

(8.) *Of the darkness produced.* Having seen a total eclipse under nearly the same circumstances of cloud as this large eclipse, I can testify to the truth and sufficiency of a remark by the Astronomer Royal with reference chiefly to the eclipse of 1842—viz., that there is all the difference in the world between a total, and a merely large eclipse; and that as long as there is the least visible portion of solar surface left outstanding, nothing like night supervenes. When that last part goes, and the large eclipse becomes a total one, then, whether the sky be clear or clouded, real darkness suddenly comes down, and wants no nice observation or prepared attention to perceive it. With reference to the clearing away of the small degree of darkness that was produced, having struck myself, as well as bystanders, as having been more rapid than its coming on, I can only consider it as an error of the senses, similarly with the reputed large size of the moon near the horizon; and the effect is easily referable to the optical nerves being more sensible to an increase than a diminution of light; for,

on turning up a gas-burner in a room previously dark, the eyes are positively pained, while, on turning it down, no such consequence follows.

(9.) *Of Baily's beads.* Though these phenomena themselves were not seen, others, throwing light on their nature and mode of production, were. Thus, the Rev. Baden Powell has suggested that they are effects of irradiation of the sun's light acting on the serrated edge of the moon, and intensified by the increase of the sun's light from circumference to centre, as well as by the "mottling" of every part of his disk. That such intensifying of the depth of minute serratures of the moon's limb would follow from such cause, I have recently found well indicated, by viewing with a telescope an artificial eclipse of a lime-ball in various degrees of incandescence, by the edge of a round file; and it is also witnessed to by the particulars described in our No. 4; while No. 2, again, shows, altogether independent of such a cause, though both may exist together, that when the solar crescent is reduced to a line of light of less diameter than the telescopic disturbances and undulations witnessed on the sun and moon's limb, it could not but be visibly broken up into a series of separate particles of light. This effect, dependent on Newton's "tremours of the atmosphere," may be further modified by those imperfections of telescopes which make one instrument exhibit a star as a different form of light to what it appears in another, and both of them make it different to what it should appear seen through no atmosphere and a perfect telescope; and in the same way, a friend with very bad eyes, according to his own free confession, tells me, that in a recent voyage to North America, when he daily watched the sunset, he observed that the instant the lowest point of the sun's lower limb touched the sea-line, the whole of that limb instantly shot across the intervening space, and gave the lower half of the sun completely vertical sides.

(10.) In the phenomena of Baily's beads, as described by various former observers, and allowed by them to set most provoking limits to the degree of accuracy with which the instant of formation or rupture of the annulus be observed, there may be mixed up the effects of all the sources indicated above. If the first thereof be cosmical and irremediable, the second, or the effect of the tremours of the atmosphere, the most certainly present of them all, admits of great alleviation, by raising the telescope up a mountain's side into the rarer regions of the atmosphere; as may be so powerfully done in the approaching total eclipse of next September on the Peruvian Andes. After having myself tried the mountain experiment and found it successful, I may be disposed to overrate it; yet when I saw that the clouds—which over all Great Britain so completely covered the heavens on the day of the late eclipse, and defeated the best intentions of thousands of well-appointed observers—were only some 3 to 5000 feet above the level of the sea, and would therefore have in no way interfered with an observer at such a height as could easily

be commanded in Teneriffe, I could only think of what advantage might follow to many other exact telescopic observations in Astronomy, were one observer at least maintained *above* the clouds.

April 9, 1858.

Observed at Haddenham, near Thame, by the Rev. W. R. Dawes.

Having decided on viewing the eclipse from my own observatory, I employed an excellent $7\frac{1}{4}$-inch object-glass recently received from Mr. Alvan Clark. It is mounted on my Munich equatoreal stand.

The sun was clouded at the time of first contact; but in about one minute afterwards it became visible through thin clouds. The edge of the moon advancing upon the sun was usually very tranquil and sharply defined. Magnifying power employed 97.

The steadiness and distinctness of the image induced me to pay especial attention to the appearance of well-marked *pores*, and small bright spots, or *luculi*, on the sun's surface, as the moon approached and occulted them. Keeping my eye steadily upon them, I was able, in numerous instances, to note whether the edge of the moon produced any dimness or distortion, or change of place as it touched and passed over them. The same close attention was bestowed upon the best-defined portions of the extremely delicate network connected with the magnificent mass of solar spots; which was just completely occulted by the moon when the clouds thickened, and the sun was seen no more till after the eclipse terminated.

The result of this careful scrutiny was, that in no instance was either a bright or a dark object affected by the vicinity or contact of the moon's edge previously to its occultation. No dark shade adhering to its edge was seen on the bright parts, nor was any bright line visible on the dark parts, as they successively disappeared. No distortion, or tremour, or projection, was perceived in any of the numerous objects thus examined during the fifty minutes of visibility.

At the greatest obscuration the darkness was not greater than occasionally happens before a heavy storm; but the aspect of surrounding objects, both near and remote, was certainly very peculiar; the prevailing tint being *purplish* or a *deep lilac*. The larks, which were previously very merry, ceased their songs for about a quarter of an hour, and an unusual and solemn quietness prevailed during that period.

The increase of light seemed to be remarkably more rapid than had been its decrease; and in five or six minutes after the greatest obscuration, the existence of so large an eclipse would scarcely have been suspected. Yet there was no apparent corresponding difference in the density of the clouds, which were almost uniformly distributed.

Haddenham, near Thame, 1858, *April* 8.

Observed at 138 Fleet Street, by W. Simms, Jun. Esq.

Having intended to observe with the sextant the distance between the points of the bright cusps as soon as formed, I made preparation for doing so at the commencement of the eclipse, being just then engaged upon measuring the sun's diameter, with a view to obtain the index-error of the instrument.

The sky was very clear at the time, and the first contact of the moon's limb well seen. This occurred at $23^h\ 41^m\ 34^s$ approximately (observed by Mr. F. W. Simms).

I frequently watched the progress of the moon's disk over the sun, with a 30-inch telescope of $2\frac{1}{4}$ inches aperture, power 65; and during the time the sky remained clear could detect no difference between the density of the dark sky and the moon's surface, a tolerably dark shade being required for the eye to bear the light of the sun.

When the eclipse had pretty far advanced, probably about a fifth of the sun's diameter being covered, a thin cloud or haze spread itself over the sky, and an exceedingly light neutral tint shade was sufficient; I then distinctly saw the moon's edge for a distance of about five minutes beyond the sun's limb, the moon's surface being also of a different shade from the sky beyond, reminding me of the colour of the dark surface at the time of the time of the young moon.

The thin haze soon after this rapidly changed to a dark cloud over the whole of the sky, and rendered further observation impossible.

The lune was just seen through a break in the cloud at the time of the greatest obscuration, and also at a few intervals afterwards; but not sufficiently for any observation to be obtained. The amount of daylight was quite sufficient for the thermometers to be read without any difficulty, even at the darkest period; but the air was decidedly chilly to the feelings.

I read the wet-and-dry bulb thermometers, and Mr. Henry Simms the standard barometer, the results are given below:—

Time. d h m	Dry Bulb. °	Wet Bulb. °	Barometer, reduced to 32°.
14 22 0	49·3	44·3	
22 30	50·8	44·9	
23 0	51·7	45·3	29·883
23 41	53·2	45·9	
15 0 0	52·9	46·0	29·892
0 30	51·2	45·0	29·907
1 0	50·0	44·4	29·907
1 15	50·5	45·0	
1 30	50·9	45·3	29·906
2 0	51·2	46·2	29·906
3 0	51·0	47·4	29·906

Observed in the Garden of R. Wafford Eve, Esq. M.D., High Street, Deptford, with his 30-inch achromatic telescope, by J. W. Breen, Esq.

Before the beginning of the eclipse, solar spots were carefully looked for, to assist in determining the connexion between them, or the faculæ usually present in their neighbourhood, and the phenomena of the rose-coloured prominences. A well-defined group of spots, with penumbræ, was seen, as represented in the accompanying sketch.* Owing to the clouds, the first contact could not be observed; and when the sun was seen at $11^h\ 45^m$, it was already indented by the moon's limb, close to which the solar surface seemed brighter than in the centre, probably by contrast with the dark lunar disk. At this time the cusps appeared to project beyond the sun's limb, particularly the cusp towards the sun's eastern edge, which jutted forward like a point of light—such as a star appears in the telescope during the daytime. Although much interrupted by passing clouds, irregularities were observed along the moon's limb at $12^h\ 4^m$, which were best seen towards the eastern cusp. By $12^h\ 20^m$ these appearances were not so conspicuous; and the cusps, though well defined, did not seem to project, as previously noticed. The sky, till $12^h\ 30^m$, was completely obscured by clouds, which presented, as the gloom increased, the same lowering appearance as those seen on a thoroughly rainy day. The coloured glasses were now abandoned, and not used again. At $12^h\ 33^m$ the moon's limb was passing over the solar spots. Whilst this was taking place, their definition, as seen through the cirrus clouds, underwent no change; and as the moon's hard outline moved onwards, they gradually disappeared from the view. At the time of greatest obscuration, the loss of light, though very small, was sensible; yet distant objects could be perceived as easily as upon any dull day; and their appearance was scarcely as much affected as it would have been by the shades of evening.

The Thermometer.

	h m	°	h m	°
At	12 0	51·0	12 36	49·7
	12 12	50·7	1 5	49·1
	12 25	50·3	2 12	50·9

I was confirmed in the foregoing impression by Dr. Eve, who was present the whole time.

Observed at Leyton, by J. G. Barclay, Esq.

I made preparations for watching any changes of temperature that might occur, and the state of atmospheric damp and dryness, by placing dry-and-wet bulb thermometers in the shade, and black

* The author here refers to a fine group of spots which was visible on the day of the eclipse near the centre of the solar disk.

bulb and plane glass exposed to the full rays of the sun, but the speedy and total obscuration of that luminary prevented any satisfactory results being obtained. The barometer was also carefully watched throughout the time of the eclipse, and exhibited the following progressive rise in the mercury until 12 o'clock, when it became stationary :—

$9\frac{1}{2}$ A.M.	29·80	$12\frac{1}{2}$ A.M.	29·85
10	29·81	1	29·85
$10\frac{1}{2}$	29·83	$1\frac{1}{2}$	29·85
11	29·84	2	29·85
$11\frac{1}{2}$	29·84	$2\frac{1}{2}$	29·85
12	29·85		

In order to prevent the fracture of the dark glasses of the eye-pieces of my telescope by the concentrated heat of the sun's rays, I prepared rings of paste-board, which were placed within the dew-cap, reducing the aperture of the object-glass from $7\frac{1}{2}$ inches clear, to $6\frac{1}{2}$, $5\frac{1}{2}$, 4 and $3\frac{1}{2}$, with the intention of removing them one by one, as the sun became more and more obscured. As, however, my observation extended over a period of about 25 minutes only, I had not occasion to admit more light than the first ring of $3\frac{1}{2}$ inches aperture permitted.

The first contact occurred in the midst of a heavy cloud, and I was consequently unable to test the time. As the moon advanced over the disk of the sun, an unevenness of outline was observable along the upper or western limb (as seen in the equatoreal). This increased as the outline of the moon enlarged, and at about $12^h\ 10^m$ P.M., when a total obscuration by clouds took place, it presented an appearance very similar to the accompanying sketch. One very prominent conical elevation was striking, followed by a depression apparently lower than the regular curve of the moon's figure, then two distinct minor elevations occurred, the whole rugged outline occupying about one-third of that portion of the moon visible on the disk of the sun. The eastern or lower limb of the moon was apparently a portion of a regular circle, but wavy with atmospheric disturbance. I could discover no difference whatever between the colour of the pure blue sky and that part occupied by the orb of the moon.

There was a very beautiful system of spots visible on the surface of the sun all the morning, which bore minute examination with higher powers. That used to observe the eclipse was 40.

At the period of greatest obscuration I left the observatory, and looked round the neighbouring fields, but could not detect any very peculiar appearances in nature, further than may frequently be observed on the approach of a heavy hanging thunder-cloud, especially towards the afternoon or evening of a summer's day. The air was remarkably still, a brisk N.N.W. wind which had been blowing all the morning having entirely subsided soon after mid-day.

My observatory is situated at Leyton, Essex, in

Lat. 51° 34′ 33″ N. Long. 14ˢ W.

Leyton, 31st March.

Observed at Hartwell Observatory, by Admiral W. H. Smyth.

Though the late eclipse, as a whole, is regarded as a "failure," still there are so many disjointed observations, that a fair estimation of the phenomenon may be made. And I therefore offer one of them.

For a complete attack of this eclipse, it was previously arranged that I should remain at the Hartwell Observatory, there to measure the cusps and take every advantage of the equatoreal instrument, while Dr. Lee, and Mr. Isaac Fletcher, who had kindly volunteered his aid to me, repaired to Towcester, in Northamptonshire, in order to watch the phenomena over the central annular line of the eclipse.

The morning of the 15th opened as finely as possible, and I went early to map the solar spots and arrange the minor matters; but before 10 A.M. the wind freshened up from the north-west, and the whole sky was overcast. At about $11^m\ 35^s$, the clouds became fleecy, so as to reveal the luminary, although a driving scud was passing over its surface. The telescope—with reduced aperture and a positive micrometer eye-piece of 62—was now pointed to the place where the moon would approach the solar orb in the inverted field; and while catching a firmish gaze, a tremulous motion of the sun's disk, followed by a faint dark line, announced the commencement of the eclipse's first contact, at $23^h\ 8^m\ 25^s$ sidereal time. As the line strengthened, masses of cumuli again got the mastery; but a little after noon it partially cleared, and the moon was finely seen approaching a remarkable group of spots beyond the centre in the north-following quadrant of the solar disk, the nearest of which she occulted exactly at $23^h\ 49^m\ 56^s$, sidereal time. The cusps were then very acute, and the lunar limb sharp and smooth. Soon after this, it again clouded over, and we saw no more of the eclipse.

Towards the central time of the phenomenon, the atmosphere assumed a dense leaden-violet tinge, resembling the coming-on of a squall or a thunder-storm; but it was never too dark for my reading the hour-circle of the equatoreal without artificial light.

The barometer, thermometer, and hygrometer, were carefully noted, and due attention paid to other particulars not necessary to be detailed in this communication.

Meanwhile, Dr. Lee and Mr. Fletcher occupied their stations at Towcester, where, according to the reports now before me, the weather was even worse than at Hartwell. This occasioned an alteration of plan; and it was agreed that Mr. Fletcher should ascend the church steeple to notice effects on the surrounding parts, while Dr. Lee, and his assistant, Mr. T. Horton, remained with the instruments and noted the atmospheric ranges, which were carefully recorded at settled intervals between 11^h A.M. and $2^h\ 30^m$ P.M. There is, however, nothing like being ready; for while Mr. Fletcher was on the steeple, suddenly the clouds opened, and he very distinctly saw the interesting effect of irradiation—the solar light impinging on the lunar edge so as to intermingle the dark and the bright limbs, and thus, under certain circumstances, produced the so-called "Baily's Beads."

St. John's Lodge, Aylesbury, 17th March.

Observed at Cardington, Bedford, by Mr. M'Laren.

(*Communicated by S. C. Whitbread, Esq.*)

A fine group of spots, three of sensible magnitude, was visible near the centre of the sun's disk.

	h	m	s	
First contact	11	39	30	G.M.T.
Contact of moon's limb with first small spot ...	12	25	0	
Contact with middle large spot	12	26	10	
Last spot disappeared	12	31	0	

Observed at Ipswich, Suffolk, by C. Stuart, Esq.

On the 7th March, I began taking altitudes of the sun, and continued them at intervals during the week to ascertain the rate of the clock and watch.

The calculated time of the beginning of the eclipse was $23^h\ 48^m\ 6^s$ Ipswich mean time.

At $23^h\ 47^m$ the wavy light seen upon the circumference of the sun was certainly more fluctuating and unsteady at the place where the first contact of the moon with the sun was to take place than at any other part of the sun's edge.

At $23^h\ 48^m$ a small cloud obscured the sun; the eclipse had not then commenced. At $23^h\ 48^m\ 28^s$ the cloud had passed over,

and the eclipse was seen to have begun some seconds; and I have no doubt the contact would have been seen to have taken place at the exact calculated time, and also that the time shown by the clock was correct.

At $23^h\ 43^m$ a prominence, or lunar mountain, was distinctly visible on the lower part of the moon, and upon consulting a map of the moon this evening, I find it is the one named Skickardus.

At $23^h\ 57^m$ the light from the sun was very distinctly seen within the edges, and slightly illuminating the dark body of the moon for a short distance, and had the appearance at its termination of three faint bands or fringes of light parallel with the edge of the moon; my impression at the time was that the solar light was inflected by a rare lunar atmosphere, however doubtful. It was in the light passing inwards along the convex surface of the moon that the before-mentioned lunar mountain was situated; it did not appear to me directly on the edge, but a little inside of it, but still high enough for the top to be beyond the edge, and appear in dark relief upon the sun's disk. I have been in the habit of observing the moon for years under all its phases with achromatic and reflecting telescopes of various sizes and powers, but never was more gratified than on viewing this lunar mountain under such circumstances.

At $0^h\ 29^m\ 26^s$ the moon's limb was in contact with the edge of the first spot; at $0^h\ 30^m\ 24^s$ it was covered; thus giving its bisection $0^h\ 29^m\ 55^s$.

At $0^h\ 34^m\ 35^s$ the moon's limb was in contact with the large group of spots; at $0^h\ 39^m\ 30^s$ the whole group was covered. Clouds prevented the exact time of their reappearance being noted down.

At $0^\circ\ 45^m$ the clouds began to increase, but still were sufficiently broken at intervals to get several good views of the eclipse, particularly at the greatest obscuration, which was seen to much advantage and gratification by very great numbers of persons. At $1^h\ 49^m$ the clouds became one dense mass, and all further observations were at an end.

The telescope I used (which I mounted equatoreally) is an achromatic of 34 inches focal length, and only $1\frac{7}{8}$ inch aperture, with a power of 35; field of view, 50′; but a most excellent defining one, and I used it in preference to another achromatic of $2\frac{3}{4}$ inches aperture and 46 inches focal length, or a 5-foot reflector with a 5-inch aperture.

As the eclipse proceeded, I took some measures with a sextant of the angle between the cusps, but upon examining them since, I think they are too faulty to copy out, and of no value.

Elm Street, Ipswich, Suffolk.

Observed at Burnley, Lancashire, by T. T. Wilkinson, Esq.

1. At the time of commencement the sky was totally obscured, and no hope existed that the eclipse could be seen at any period of its duration.

2. Shortly before 12 o'clock, however, the strata of clouds began to appear less dense, and at $12^h\ 5^m$ the disk of the sun became distinctly visible through the haze. The moon had then obscured a considerable portion of the lower part of the sun's disk.

3. After an interval of about 15 minutes, several openings were formed through the clouds, and an opportunity was afforded for observing the colour of the sky. This at first seemed of a dark purple hue; but it shortly changed into what an artist would probably call a dirty grey. The mixture of purple and grey was most evident round the edges of the openings; whilst the centre of each exhibited a near approach to a deep black, and seemed to project towards the observer from the rest of the opening.

4. At $12^h\ 35^m$ the clouds cleared away from the vicinity of the sun, and for the space of ten or twelve minutes the eclipse was observed at the greatest advantage.

5. From this time ($12^h\ 46^m$) to near the close, the scudding haze occasionally obscured the sun, but at rapid intervals the progress of the eclipse was observed without much interruption or inconvenience. Indeed the hazy clouds served as a medium through which the eclipse could be seen without the use of smoked or coloured glasses; for it was only when these were absent that glasses became necessary. Many of our population observed the eclipse most effectually during the absence of the clouds, by turning their backs upon the sun, and noting his phases as reflected from the apparently dark windows of the shops.

Burnley, Lancashire, March 17.

Observed near Oundle, Northamptonshire, by James Glaisher, Esq. F.R.S.

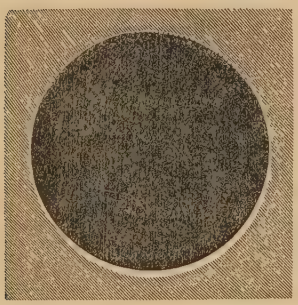
"For the observation of the solar eclipse of March 15, I made choice of Oundle, in Northamptonshire, from its being situated on, or very nearly on, the line of central eclipse as last calculated.

"I was very desirous of obtaining, if possible, a complete set of meteorological and physical observations in addition to those which were purely astronomical. In this I was greatly assisted by having associated with me Mr. Adams, late Assistant-Secretary of the British Meteorological Society, and whose presence with me at the time was of great value, as I could entrust to him with the utmost confidence the readings of the very delicate and accurate thermometers expressly prepared for this occasion, at my

request, by Messrs. Negretti and Zambra. In these observations he was assisted by Mr. Symons; and to the perseverance and care of these two gentlemen I owe the excellent series of meteorological and photometric observations which, during the greatest discouragements of weather, they continued to make from 9^h A.M. to 4^h P.M."

Mr. Glaisher attentively marked the progress of the eclipse, obtaining occasional glimpses of the phenomenon through the openings of the clouds.

"At $0^h\ 59^m\ 50^s$ I again saw the sun tolerably free from clouds; the cusps were still separated by about 70°. From the apparent highest part of the sun, and extending round his circumference to the apparent right hand for a space of 60° nearly, there were a series of bright and dark intervening spaces, irregular in size and distance from each other, evidently caused by the irregularities in that part of the moon's circumference, which was about passing off the sun; the remaining portion of the sun's limb was unbroken. The moon was black, and her limb was separated from that of the sun, at the widest part by a space which I estimated to be about the same as that of the break on the sun's limb, first noticed; viz. from 15″ to 20″; this width gradually tapered off, on approaching the apparent eastern cusp, to the finest possible point, still separated by 70° or 80° from the other cusp, but which space was evidently decreasing by the visible increasing of the lower cusp." (See annexed figure.)



Unfortunately, a little before the completion of the annulus, the interposition of a cloud entirely concealed the sun, and the most interesting feature of the eclipse was thus lost. Mr. Glaisher thus proceeds:—

"As the eclipse progressed, the change in the colour of the sun itself was very marked, the crescent becoming of a pure silvery brightness, like that of Venus after inferior conjunction with the sun. I cannot say the time when this change commenced, but I suppose it to have been gradual; I first noticed the alteration when the crescent was becoming very narrow and fast approaching the calculated time of annularity, when the absence of all yellow in the light must, I think, have struck every one. The illuminating power of the sun, or, I should say, of that part which remained visible, was very considerable even up to the time of the greatest eclipse; and the partial illumination on those objects receiving direct sunlight, when the sun was free from cloud, was much more than might have been supposed commensurate with the small portion of the sun's disk, which remained

uneclipsed. A peculiarity in the appearance of the landscape at this time was the glow of sunlight over objects apparently situated immediately beneath the sun, whilst the horizon all round was enveloped in gloom. This peculiarity was exhibited to the best possible advantage from the view commanded by my position.

"Beyond destroying the peculiar disposition of light and shadow, the interposition of the clouds before the sun had little effect in reducing the amount of light upon the landscape; and when not looking at the sun it was not immediately apparent whether or no the remaining part of his disk was free from clouds. This I attribute, in great part, to the reflexion of light from the screen of clouds, which, partially broken and variable in density, assisted in the dispersion of a considerable amount of light absorbed by them, in the first instance, from the sun itself. This, which I noted at the time, was subsequently confirmed by the photometer scale, as composed of slips of photographic paper exposed at regular intervals for five minutes.

"This scale was commenced at 10^{h} A.M., and continued onwards till 4^{h} o'clock. The exposure of the paper and recording of the times of observation was entrusted to Mr. Adams, and through all changes of the weather indicates unmistakably the loss of light due to the eclipse. In since fixing the photographic impressions, it should be borne in mind that the deeper tints have become lighter in the process, whilst the feebler portions marking the occurrences of the greatest phase remain unaltered. The following table contains the result of experiments made by noting the time photographic paper was tinged, and when it came to a definite tint on exposure:

Photometric Observations with Photographic Paper.

Time of Exposure.	Paper slightly Tinged in Seconds.	Paper coloured to a certain Tint in Seconds.	Time of Exposure.	Paper slightly Tinged in Seconds.	Paper coloured to a certain Tint in Seconds.
h m	s	s	h m	s	s
10 30 A.M.	10	55	12 0 Noon	5	40
45	22	65	5	7	60
11 0	20	70	10	8	60
15	12	40	15	10	...
30	15	20	20	11	40
35	5	15	25	6	50
40	4	30	30	3	25
45	6	30	35	6	40
50	6	40	40	5	40
55	5	31	45	10	63

Time of Exposure.	Paper slightly Tinged in Seconds.	Paper coloured to a certain Tint in Seconds.	Time of Exposure.	Paper slightly Tinged in Seconds.	Paper coloured to a certain Tint in Seconds.
h m	s	s	h m	s	s
12 50 A.M.	7	45	1 55 P.M.	30	90
55	11	90	2 0	10	60
1 0 P.M.	20	120	5	15	60
5	20	150	10	10	45
10	20	120	15	10	60
15	30	120	20	10	60
20	10	90	25	10	60
25	20	120	30	10	60
30	20	120	45	10	39
35	15	70	3 15	11	40
40	20	90	30	7	43
45	20	90	45	11	50
50	15	75			

From these observations it is evident that a great diminution of light gradually took place, from the commencement of the eclipse up nearly to the time of the middle, when it very rapidly further declined; after the middle of the eclipse had passed, a continuous rain fell, and the clouds were unbroken; nevertheless, the light at first rapidly increased, and afterward with less rapidity, till the end of the eclipse.

The depression of temperature during the eclipse was a little more than 3°.

The temperature of the dew-point was very variable throughout the day. From 9^h A.M. to 10^h A.M. it was about 40°, increased to 46°·8 by $11^h\ 15^m$; decreased to 41° at $11^h\ 40^m$; increased to 45°·3 at $10^h\ 25^m$ P.M.; decreased to 42° at $0^h\ 45^m$; increased quickly to 46° about the middle of the eclipse, and afterwards varied from 42° to 46°.

The degree of humidity had varied from 72 to 92 before the eclipse, increased to 96 at its middle, and varied from 79 to 93 afterwards.

The reading of a blackened bulb thermometer varied considerably in the morning before the eclipse. It will be remembered that the sun shone early in the morning with varied brightness. At $1^h\ 40^m$ its reading was 62°, which gradually declined to 44°·5, the temperature of the air at the middle, and then increased to 52° by the end of the eclipse.

The following table shows the temperature of the air and its hygrometric states from 9^h A.M. to 4^h P.M. For the general discus-

sion of meteorological observations over the country, see Proceedings of the Meteorological Society.

Meteorological Observations at Oundle on March 15, 1858.

Time of Reading.	Thermometer in Shade.		Dew-point.	Elastic Force of Vapour.	Weight of Vapour in a cubic foot of Air.	Short of Saturation.	Degree of Humidity. Sat. 100	Thermometer in Sun.		
	Dry Bulb.	Wet Bulb.						Dry.	Wet.	Black Bulb.
h m	°	°	°	in.	gr.	gr.				
9 0 A.M.	45·3	42·8	40·0	·247	2·8	0·6	82	51·4	48·2	62·0
15	46·1	43·4	40·3	·251	2·9	0·7	81	51·9	47·9	64·3
30	46·4	43·4	40·0	·248	2·9	0·8	80	48·8	45·4	54·6
45	47·0	44·0	40·6	·253	2·9	0·8	79	50·4	46·4	51·5
10 0	47·3	44·0	40·3	·250	2·9	0·9	77	50·8	48·6	56·6
15	48·0	45·0	41·7	·263	3·0	0·8	79	49·7	47·8	56·8
30	48·2	46·1	43·8	·285	3·3	0·5	85	49·6	46·5	56·6
45	49·1	46·4	43·5	·284	3·2	0·8	81	50·3	45·9	57·0
11 0	49·0	47·3	45·4	·305	3·5	0·5	88	49·8	46·9	56·5
15	49·1	48·0	46·8	·321	3·7	0·3	92	49·9	46·1	57·0
30	49·6	46·9	44·0	·289	3·3	0·7	81	50·3	47·2	57·5
35	49·9	46·5	42·9	·277	3·2	0·9	77	51·2	47·2	59·0
40	49·8	45·5	40·9	·257	2·9	1·2	72	51·1	47·2	60·0
45	49·9	46·5	42 9	·277	3·2	0·9	77	51·2	47·1	59·4
50	49·6	46·1	42·4	·271	3·1	1·0	76	50·5	46·8	58·5
55	49·8	46·5	42·8	·276	3·2	0·9	76	50·9	47·0	56·5
12 noon	49·2	46·1	42·8	·276	3·1	0·9	79	50·2	46·6	54·8
5	49·1	46·1	42·9	·277	3·1	0·9	79	50·2	46·6	55·4
10	49·5	46·5	43·3	·281	3·2	0·8	79	50·4	46·8	57·5
15	50·0	46·8	43·4	·282	3·2	1·2	79	51·2	47·4	58·8
20	50·8	47·5	44·0	·290	3·3	0·9	78	52·7	48·9	62·2
25	50·4	47·9	45·3	·303	3·4	0·7	83	52·3	47·9	58·9
30	49·5	46·5	43·3	·281	3·2	0·8	79	50·8	47·8	55·0
35	49·2	46·1	42·8	·276	3·1	0·9	79	49·9	46·2	56·2
40	49·0	46·0	42·8	·276	3·1	0·9	79	49·5	46·0	51·9
45	48·5	45·5	42·2	·270	3·1	0·8	79	48·8	45·5	50·2
50	47·2	45·7	44·1	·290	3·3	0·4	89	48·2	44·8	48·7
55	47·6	45·2	42·5	·272	3·1	0·6	84	47·6	44·2	46·8
1 0	47·4	46·5	45·5	·305	3·5	0·3	94	47·8	43·5	45·1
5	47·1	46·4	45·6	·307	3·5	0·2	95	46·2	43·4	44·4

Time of Reading.	Thermometer in Shade.		Dew-Point.	Elastic Force of Vapour.	Weight of Vapour in a Cubic Foot of Air.	Short of Saturation.	Degree of Humidity, Sat. 100	Thermometer in Sun.		
	Dry Bulb.	Wet Bulb.						Dry.	Wet.	Black Bulb.
h m	°	°	°	in.	gr.	gr.				
1 10 P.M.	47·0	46·5	45·9	·3 0	3·5	0·2	96	46·2	43·5	44·6
15	47·2	44·6	41·7	·264	3·1	0·7	82	46·5	43·8	45·0
20	47·0	44·0	40·6	·253	2·9	0·8	79	46·8	44·0	45·6
25	46·9	44·5	41·8	·265	3·0	0·7	83	46·5	43·9	46·7
30	47·1	44·9	42·5	·272	3·2	0·5	85	46·8	44·0	47·6
35	47·2	45·0	42·6	·273	3·2	0·6	85	46·7	44·8	48·0
40	47·2	45·1	42·8	·275	3·2	0·5	86	46·7	45·0	48·5
45	47·3	45·2	42·9	·276	3·2	0·6	86	46.8	45·1	48·9
50	47·2	45·1	42·8	·275	3·2	0·5	86	46·7	45·0	48·7
55	47·2	45·1	42·8	·275	3·2	0·5	86	46·1	45·0	48·5
2 0	47·8	46·8	45·7	·308	3·5	0·3	93	46·6	45·6	49·6
5	47·7	46·0	44·1	·289	3·3	0·5	88	47·2	46·2	51·0
10	47·7	46·1	44·3	·291	3·3	0·5	89	46·8	46·0	50·8
15	47·8	46·2	44·4	·293	3·3	0·5	89	47·0	46·6	52·5
20	48·0	46·6	45·1	·299	3·4	0·4	90	47·9	47·8	51·9
25	47·8	46·2	44·4	·293	3·3	0·5	89	46·9	46·8	51·4
30	48·1	46·6	45·0	·298	3·4	0·5	90	47·4	47·1	51·9
45	47·8	46·2	44·4	·293	3·3	0·5	89	46·6	46·1	49·2
3 0	47·9	46·2	44·3	·292	3·3	0·5	88	46·3	46·8	47·5
15	48·4	46·5	44·4	·293	3·3	0·5	87	46·7	46·4	49·1
30	49·0	47·1	45·0	·300	3·4	0·6	87	47·6	47·0	51·1
45	49·0	47·1	45·0	·300	3·4	0·6	87	47·8	46·8	49·4
4 0	49·1	47·3	45·3	·304	3·5	0·5	87	48·2	47·2	50·0

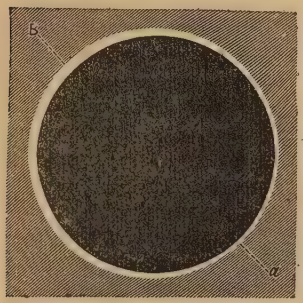
In the evening of March 13 there was a fine display of aurora, seen all over the country. Auroral light was conspicuous during the evenings of the 14th, 15th, 16th, and 17th.

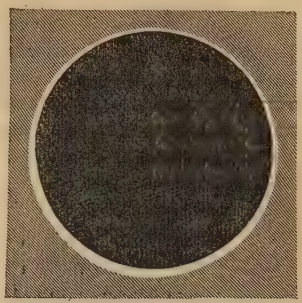
The following are extracts from letters which were addressed to Mr. Glaisher relative to the eclipse, as observed at different places.

Observed at Peterborough, by T. Sopwith, Esq., F.R.S.

"At about one o'clock the sun emerged from behind a dense cloud, and I caught it in my lesser telescope; a low power of twenty sufficing to give clearness to an excellent view of the whole disk. It was at that very moment commencing the annular

form, being narrower at *a*, and wider at B, see annexed figures, in a second or two it assumed, as near as I can judge — and my eye is tolerably correct for geometrical form — the aspect of an





equal line of light all round. I resumed my view before the ring disappeared, and observed the closing of the ring; but whether the low power of telescope or the clouds were the cause I know not, I saw no beads nor anything beyond the formation of a crescent succeeding the annulus, and then came a message that the train had arrived, in which at $1^h\ 15^m$ P.M. we were to proceed to Newcastle. I made no attempt at observations of temperature, nor even time; nor could I define with accuracy these details, for in truth I knew that Astronomy and Meteorology *were out* in great force. Had I maintained a continuous look the disks would have left their relative positions more clearly on my mind, and had I known how few were to see the actual annular eclipse, I would have taken a very exact chronometer. I was quite at a loss to account for the apparently perfect central position of the moon on the sun, but I think the view of light as I saw it, well defined and not dazzling, was as nearly as possible equal at one period along the entire circumference."

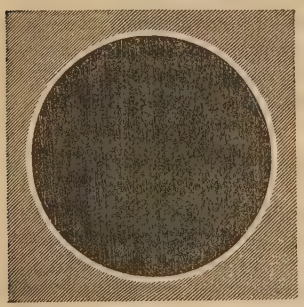
Observed at Peterborough, by Dr. Bowerbank, F.R.S.

"I *did* see the ring during the annular eclipse through a thin stratum of cloud, which was sufficiently dense to render coloured glass unnecessary, but not so dense as to prevent a distinct view of the annulus. As the moment approached for the greatest obscuration I steadily watched its proceeding; and as the moon progressed over the face of the sun, I saw the ring of light run round, as it were, on the side of the sun opposed to my left; and the first thin line like a streak of light appeared at the lower portion of the sun, and in a second or so the ring was of equal thickness at both top and bottom. I do not think, from the commencement to the termination of the annulation, the time could have exceeded three or four seconds; and it appeared to me that when about the middle,

the thickest part of the ring was to my left hand, and the thinnest to my right: but on this point I would not wish to speak with certainty. Our position was the Cathedral yard; and I believe there might have been about thirty persons present, several of whom I know, and know well. Fifteen of us, who formed a group after the middle was over, all agreed that they had seen the annulation distinctly; among these was my friend M. J. J. Fownes, Esq., actuary of the Economic, who had a telescope with him, but who saw no more than we without one. He was on the look-out for Baily's beads. No red flames were seen."

Observed at Peterborough, by Thomas Walker, Esq., M.D.

"I beg to state that on the 15th instant, walking with Mr. and Mrs. Gates on the Stamford Road, in a direction west from Peterborough, we continued, from the time I joined them, about $12^h\ 30^m$, to observe the progress of the eclipse; the strata of cloud not being so dense but that every four or five minutes the sun was visible under this at rare intervals, so brightly as to make the blue spectacles, with which I had provided myself, for a brief space useful, generally, however, the naked eye was more so. We were just about half-a-mile nearly due west from Peterborough, when Mr. Gates remarking that it was about the time of the greatest obscuration, and a break in the passing scud of cloud allowing an unusually good view of the darkened disc, we simultaneously exclaimed, 'The ring is complete!' it was so, and became whilst it so continued so bright that I was in the act of adjusting my blue glass to my eye, when the ring was lost, and the thin crescent appeared on the other side as the eclipse went on.

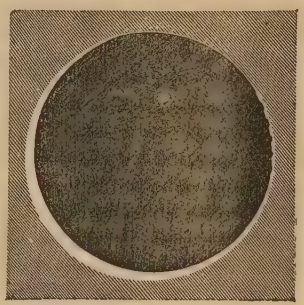


"All I can say is that the ring *was* complete, that it appeared to me of equal breadth all round, see annexed figure, but that, engrossed for the moment with the interest and the beauty of the spectacle, and with our unexpected good fortune in thus witnessing it, I can lay claim to no accuracy of observation as to its perfect equality of width in its whole circumference. The darkness seemed to me that of a cloudy evening, and the birds were chirping and singing more than I should have looked for had it been evening and equally dark."

Observed at Little Bridy, Dorset, by H. S. Eaton, Esq., B.A.

"I have not the slightest doubt that the line of central eclipse passed farther to the east than was anticipated. The eclipse was

seen from a spot about midway between Charmouth and Lyme Regis, $1\frac{1}{4}$ mile E.N.E. of the latter place. Here the ring was *complete*. Baily's beads first appeared on the S.S.W. limb of the sun, the annulus was then formed, continued for about seven or eight seconds; and on its breaking up Baily's beads reappeared on the E.N.E. limb, consequently the upper part of the annulus must have been the broader, although it was not particularly noticed. Baily's beads were formed when about 60° of the circle were wanting. The ring was seen at Charmouth, but from this place eastward as far as Abbotsbury, which is three miles S. by W. of Little Bridy, the sun became visible almost exactly at the time of greatest obscuration. Baily's beads were seen at the lower cusps on the western limb of the sun, but none on the upper limb; about 230° of a circle were formed, and Baily's beads were supposed to occupy 30° more, as in the annexed figure. These numbers, however, are stated with considerable diffidence, as in no case were actual measurements taken."



Second communication from Mr. Eaton, dated April 5th.

"Several persons stationed themselves at a spot one mile west of Lyme on the supposed line of central eclipse; here no annulus was formed, the ring being incomplete on the south-east limb of the sun, while at a distance of three-fourths of a mile farther east, on the outskirts of Lyme, a ring was visible for a moment. From this it appears that the western limit of the annular eclipse passed about half-a-mile to the west of Lyme. I may further add that the eclipse was seen from a high cliff called the Golden Cap, one mile and a half east of Charmouth, and that here the ring seemed of even dimensions. Charmouth is two miles from Lyme, and the Golden Cap rather more than two miles from Charmouth."

Observed at Royston, by Hale Wortham, Esq.

"At Royston the eclipse was pretty fairly visible nearly throughout, and I much regret that I was not at home to see it. One friend of mine (using a small Gregorian reflector without a dark glass at that time) tells me that about 1 o'clock he distinctly saw red bands crossing the upper horn of the crescent, and continuing over about one-third of the bright lune, but he could not trace them as projecting beyond the sun's limb. My mother and another lady, observing with the eye only, noticed a little while before the eclipse was at its greatest phase, a singular

dusky red line down the centre of the bright line. I am disposed to look upon this as an optical delusion (although seen by two persons), but mention it as it may possibly be confirmatory of what some one else has seen. The same ladies also remarked that during the eclipse the clouds surrounding the sun were beautifully tinted with red."

Mr. Glaisher thus concludes his paper:—

"From these accounts it is quite clear that the calculated line for central eclipse by Hansen's Tables is in error. From my own observations in approximate Latitude 52° 30′ N., and estimated Longitude 0° 28′ 20″ W., I was situated very nearly on the northern or western limit of annularity, as I saw the moon's south limb graze along the south limb of the sun. From the observations at Peterborough of Mr. Sopwith, Dr. Bowerbank, Dr. Walker, and many others, it would seem that the central line was not far removed from that city; and from the observations made at Lyme Regis, Charmouth, the Golden Cap, &c., it would seem to have passed about four miles south of the calculated line. Therefore, from all the observations, the most probable line of central eclipse passed a little west of Peterborough, or about four miles south of the calculated line by Hansen's Tables, and about one-fourth of a mile north of the line indicated by Burckhardt's Tables."

Observed at Appleby, Lincolnshire, by J. E. Cross, Esq.

Lat. 53° 37′ 10″ N. Long. $0^h\ 2^m\ 16^s$ West.

The time (Local Mean Time) uncertain to a few seconds.

First contact not observed.

$11^h\ 42^m\ 30^s$. Moon well on sun's limb. Protuberances very visible in the south part of moon's limb; one very large.

$0^h\ 15^m\ 0^s$. The mottled flocculi of the sun's surface seemed to become bordered with darker shades than usual, giving something like the appearance of very dusty lenses.

Soon after the greatest obscuration, as the cusps were quickly wheeling round, saw (at least twice) the point of the south cusp isolated.

The light increased almost immediately, and very rapidly after the moment of greatest obscuration.

Soon after the sun began to show decidedly brighter, I observed a faint crescent of light on the moon inside the solar crescent. (When I say *faint*, I mean faint through the colour shade.) The sun was always too bright to look at when clear of clouds.

Observed with a refractor $3\frac{1}{2}$ feet focal length, and $2\frac{3}{4}$ inches object-glass narrowed to 2 inches. Power 35; occasionally 80 and 130.

15th March.

Extract of a Letter from Professor Challis to the Secretary accompanying the following Communication.

"I send an instalment of a communication I propose to make to the Royal Astronomical Society respecting the eclipse of March 15, which was better seen at Cambridge than at most places in England. I will send the rest as soon as I can finish. In the meantime I can mention some results that I have arrived at. The times of beginning and ending of the eclipse were both *later* than as predicted in the *Nautical Almanac*. Burckhardt's geocentric R. A. of the moon's centre requires the correction $-2''{\cdot}9$, and the geocentric N. P. D. $+2''{\cdot}6$. The semidiameter of the moon in the *Nautical Almanac*, so far as this eclipse as here observed is concerned, requires the correction $-2''{\cdot}3$. From the above errors of the moon's geocentric place, it follows that the longitudes and latitudes in the *Nautical Almanac* of 1858, p. 467, calculated for the annular phase, require respectively the corrections $+6^s{\cdot}00$ and $-90''{\cdot}7$, and consequently that the true line of central phase was to the *south* of that given by Burckhardt's Tables, and distant from it by only one quarter of a mile. It seems to be evident from rude observations that the central line by Hansen's Tables was too far northward.

Observations of the Solar Eclipse of March 15, 1858, *made at the Cambridge Observatory, and Calculation of Results from Observations.* By the Rev. James Challis, M.A., F.R.S., F.R.A.S., Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge.

As the annular eclipse of March 15, 1858, which was looked forward to by English astronomers with so much interest, could scarcely be seen at all along the central line, on account of cloudy weather, I have thought it worth while to describe the phenomena of the partial eclipse witnessed at the Cambridge Observatory, where, although the state of the sky was generally unfavourable, intervals more or less clear occurred, which allowed of noting certain physical circumstances, and of taking a few micrometer measures. Having resolved to go myself to Peakirk, a village about six miles north of Peterborough, situated very near to the computed central line, in the hope of witnessing the annular phase, I gave instructions to my senior assistant, Mr. James Breen, to take observations with the Northumberland telescope, aided by Mr. Bowden, the junior assistant. Also I offered to Mr. Hugh Godfray, M.A., of St. John's College, and one of the Esquire Bedells of the University, the use of the 46-inch Dollond, mounted out-of-doors on an equatoreal stand, which had recently been fixed to the stone area south of the dome of the 5-feet equatoreal. Mr. Godfray availed himself of the offer, and the results of his observations, of which he kindly drew up a report, are included in the following account. I propose, first, to give a

statement of the physical observations of the several observers, and then to add the micrometer measures and the calculation of astronomical results.

I. *Observations of Physical Phenomena.*

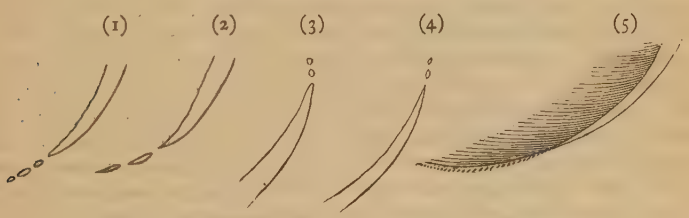
The following observations were recorded by Mr. Breen. Before the commencement of the eclipse dense masses of cumuli cloud were continually passing. The first contact was, however, detected almost immediately after it occurred, and for the next twenty-five minutes the progress of the eclipse was favourably observed. During this interval the irregularities of the moon's limb were very apparent. One remarkable prominence was especially noticed at twenty-five minutes to one o'clock. At eight minutes past noon the sky became densely clouded, and remained so for three-quarters of an hour. At $0^h\ 56^m$, about five minutes before the time of greatest obscuration, the sun appeared again suddenly through breaks in the clouds. The northern cusp was then quite regular and sharp; but the southern cusp, on being brought into the field of view, was found to be broken up into four or five rounded fragments — evidently "Baily's beads." The contiguous portion of the moon was observed to be frequently and deeply indented. The northern cusp was instantly brought again into view, but was found to retain its pointed form. At, however, 52 seconds past 1^h, broken points of light were clearly distinguished at this cusp, and twenty seconds later they were noted as "continually forming." The beads of the same cusp (the other was not again looked at) remained visible until 4^m past one o'clock, when they ceased to appear. By this time the sky had again become cloudy, and it remained so the next twenty minutes.

It was particularly remarked that the beads were continually appearing and disappearing, and changing in size, form and lustre, and that their appearance and disappearance were equally rapid. They generally took an irregularly round form; but on one occasion they appeared oblong, and the extremity of the cusp was an excessively thin line of light, having a much fainter illumination than the rest of the beads. Those on the southern cusp appeared rounder and at more regular intervals than those at the northern. Generally from four to six beads were seen at the same time, but not more. Sometimes a single point of light was isolated at the extremity of the cusp. No change in the colour of the beads was perceptible: they appeared of the same tint as the surface of the sun. No dark strings joining the borders of the sun and moon were once visible. The surface of the moon projected on the sun appeared of a very dark tint as seen without coloured glasses, but was not extremely black. No dark fringe along the sun's border was seen, nor was there any appearance of red-coloured prominences.

At one time, the sun having broken through the clouds for a brief interval with considerable brightness, the northern cusp was

removed entirely out of the field of view, and a prolongation of the moon's limb beyond that of the sun was plainly seen for a few seconds, bounded by a faint and white line of light about 20″ in breadth, which stretched almost across the field of view. Conceiving that this might be a portion of the sun's corona, Mr. Breen immediately looked into the finder of the telescope to see whether the same phenomenon could be perceived round a larger portion of the moon's disk, but the field of view was much too bright to allow of seeing anything of this kind. Excepting at the time of the last observation, when the sun was covered by very thin cloud, there was no occasion to use coloured glasses, the eye being sufficiently protected by the misty cirrus spread over the sky. Baily's beads and the faint prolongation of light beyond the northern cusp were seen without coloured glasses. A Huyghenian eye-piece of power 250 was used.

The following representations are exact copies of sketches made by Mr. Breen in his memorandum-book, immediately after the observations. Nos. (1) and (2) refer to the northern cusp, Nos. (3) and (4) to the southern cusp, and No. (5) to the faint light bordering the moon's limb.



Mr. Breen had no doubt that Baily's beads were due to irregularities on the moon's limb. As the cusp which was looked at longest, and is distinguished above as "northern," was the *retreating* cusp, it was possible, by carefully noticing the indentations of the moon's limb previous to contact with the sun's border, to anticipate the formation of isolated points and irregular ridges of light. Also the length of time during which the beads were visible in the immediate neighbourhood of the cusp is confirmatory of this explanation of their origin.

From five minutes past one o'clock till nearly half-past, the sky was quite overcast: at the latter time it became clear for a few minutes. From about five minutes past two o'clock to the end of the eclipse, the sky was pretty clear, and the final contact was observed with great accuracy.

The following account is extracted from Mr. Godfray's report to me of the observations he made with the 46-inch Dollond, the aperture of which is $3\frac{3}{4}$ inches. "The weather had been favourable up to and for some little time after the commencement of the

eclipse, when clouds, which had gradually accumulated, covered the whole sky; but as they moved at a rapid rate, they gave frequent though faint glimpses of the sun, which could then, on account of the screen thus interposed, be observed quite as well with the naked eye as with glasses. I used an eye-piece of power 75 [which took in the whole of the sun's disk]. The irregularities of the edge of the moon were well defined, but I could not see anything of the moon itself, nor any trace of the limb beyond the cusps, although I looked for it very attentively." Mr. Godfray then states that clouds prevented any observation of the passage of the moon's limb over the sun's spots, which he had intended to notice carefully, for the purpose of seeing whether any distortion of the limb took place. "As the obscuration approached its maximum, the clouds became thinner, and the glimpses of the sun more frequent, and I put on a power of 87 without any coloured class. With this I followed the *advancing* cusp of the sun, which was now reduced to a thin crescent, and I had the gratification of seeing Baily's beads forming themselves one or two at a time—never more than two—in advance of the cusp, and these were successively overtaken by the cusp and merged into it before new ones were formed. The edges of the cusp were well defined but very irregular on the inner side, and the point was blunted when one or two beads were in front. The appearance was precisely what might be expected from the interposition of the mountainous surface of the moon; and I have no doubt that the phenomenon is entirely due to the light of the sun shining through the hollows in the moon's rugged edge. It seemed to me, also, that where the beads were most frequent, the inner edge of the cusp was afterwards most jagged and irregular." Mr. Godfray further remarks that the position of Cambridge was in this instance better adapted in some respects for viewing the beads than a place on the central line, because the phenomenon could be traced in the passage of each cusp over nearly a semicircumference of the moon, whereas on the central line the appearance, though more sudden and striking, would be confined to more limited portions of the moon's border. He estimated the greatest distance the beads were at any time in advance of the cusp to be not more than 2° measured on the sun's limb.

For the purpose of testing whether the composition of the sun's light remained the same during the phases of the eclipse, Mr. Godfray furnished himself with a variety of coloured wools of different shades, some of which might be expected to approach to the same tint if the constituent parts of the sunlight altered. No such assimilation of the shades was discernible.

Mr. Bowden and Mr. Breen made the following meteorological observations. The barometer readings are corrected for index error and capillarity, and are reduced to 32° Fahr. The blackened bulb thermometer was exposed to the direct rays of the sun.

1858.	Mean Time. h m	Barometer. in.	Thermometers. Dry Bulb. °	Wet Bulb. °	Blackened Bulb. °
March 14	23 5	29·877	49·6	45·3	56·8
	23 43	...	51·7	46·6	56·7
15	0 15	29·893	51·4	45·5	56·7
	0 39	...	49·3	44·6	50·8
	1 4	...	47·7	43·7	49·1
	1 14	29·898	47·8	43·7	...
	1 19	20·903	50·9	45·6	55·3

Both observers remarked that at the time of greatest obscuration the sky was not nearly so gloomy as might have been expected, and scarcely more so than it generally is previous to a heavy shower of rain. Mr. Breen states his impression thus: "When the sun crescent was seen struggling through masses of cloud, it appeared scarcely possible that the considerable amount of light which prevailed could proceed from this slender thread of light." During the greatest obscurity the light was thought to be of a sombre, brownish hue by Mr. Bowden, who also noticed that there was at this time a general stillness, the wind, which had previously been somewhat brisk, being hushed. Birds, that had been heard singing a short time before, continued silent for about ten minutes; a flock of rooks took flight as at eventide; and when the greatest phase was over, the cocks in two neighbouring farm-yards seemed to indicate their perception of the return of light by incessant crowing. The darkness lasted a very short interval.

At Peakirk, where I was situated, the sky was so densely and uniformly clouded that I could not make a single astronomical observation. All requisite preparations were made for the purpose. My son, Mr. James Law Challis, accompanied me to render assistance; and a very commodious position for placing instruments was kindly provided by Mr. James, the clergyman of the parish, both for myself and for three other observers who came well furnished with astronomical means. All that could be done was to take some thermometrical observations, and make a rough estimate of the amount of obscuration. The temperature was recorded by Mr. Challis from two thermometers placed in a window-sill looking eastward, and from a blackened bulb thermometer attached to the telescope stand. The subjoined temperatures in shade are means of the readings of the two thermometers.

Thermometers in Shade.

Camb. M.T.	h m	°		h m	°		h m	°
Mar. 14	23 49	53·9	Mar. 15	0 19	50·6	Mar. 15	0 34	49·7
	59	52·3		24	50·3		39	49·2
15	0 9	51·2		0 29	50·0		0 44	49·0

Thermometers in Shade.

Camb. M.T.								
	h m	°		h m	°		h m	°
Mar. 15	0 49	48·7	Mar. 15	1 11	47·4	Mar. 15	1 41	48·3
	54	48·3		16	47·4		51	48·7
	59	48·0		21	47·5		2 1	49·3
Greatest phase	1 2	47·9		26	47·6		11	49·6
	6	47·5		31	47·8		18	49·7

Blackened Bulb Thermometer.

Camb. M.T.								
	h m	°		h m	°		h m	°
Mar. 14	23 42	53·0	Mar. 15	0 42	49·6	Mar. 15	1 21	47·8
	52	52·5		47	48·9		26	48·4
15	0 2	51·0		52	48·5		31	48·8
	12	51·0		57	48·0		41	49·3
	22	50·9	Greatest phase	1 1	47·5		51	50·1
	27	50·4		6	47·1		2 1	51·3
	32	49·6		11	47·4	Sun just visible	11	51·3
	37	49·2		16	47·6		18	52·2

To obtain a rough estimate of the degree of maximum obscuration, I proceeded as follows. Page 7 of Mr. Hind's Supplement to the Calculation of the Eclipse was held upright and facing the East, and I noted the distance at which the word "Errata" could be just seen to consist of separate letters, and also the distance at which this word could be just seen to be separated by an interval from the words, "In the Nautical Almanac," immediately below it. This was done at the commencement of the eclipse, and precisely at the time of greatest obscuration. The distances in the first case were 47 feet and 32 feet, and in the other 9 feet and 6 feet. The brightness with which the greatest obscuration was thus compared is that of the noon in latitude 53° N. on a day in the middle of March completely and densely overcast. The return of light after the maximum obscurity was apparently very rapid; so much so as to be the subject of general remark. This might possibly be owing in a great measure to the condition the sight had been brought into by the previous continual degradation of light. I repeated the experiment on the word "Errata" as quickly as possible after the greatest obscuration, and obtained a distance of 7 feet; but as the precise time at which the experiment was made was only roughly noted to be 1^m after the first, no exact result can be deduced from it.

Observed at Ochtertyre, Crieff, by Sir William Keith Murray.

The morning of the 15th was very clear from an early hour till 9 A.M., when the sky was completely clouded, and threatened to bar all hope of seeing any portion of the eclipse; but fortunately it cleared up at $11^h\ 20^m$, and continued so till 12. The contact of the moon was well seen; and the only phenomena observed

were the limb of the moon slightly illumined by the sun for a short time, and a high mountain on the northern limb of the moon projecting on the sun's disk.

No change was observed in the barometer.

A thermometer, exposed to the sun, fell from 50° to 40°.

There was very little change observed in the light, but a certain twilight appearance was observable, and a sensible chilliness in the air.

An owl was heard to hoot, and the crows seemed disturbed in their flight.

Ochtertyre, 20th March.

A daguerreotype of the eclipse taken at Hinton, near Farringdon, by Mr. Williams, of Regent Street, about half-an-hour before the greatest obscuration, was exhibited at the meeting of the Society. Accompanying the real phenomenon was a mock sun, which appeared in the clouds at the same time. In regard to the latter we find the following remarks by Mr. Williams, in a note which appears in the *Athenæum* of the 24th of April :—

"I do not think that the reflexion could have lasted more than a minute and a quarter or a minute and a half, dense clouds almost immediately obscuring both the sun and its reflexion. The wind was very high, blowing very heavy clouds from the north-west; above them floated other clouds thin and fleecy, moving in an opposite direction; and it was upon these that the reflexion appeared. Drops of rain had fallen occasionally before and at the time of its appearance, and in about half-an-hour afterwards a heavy shower, which lasted more than an hour. For astronomical observations, or for the recording of other instantaneous events, would you permit me to speak in favour of the daguerreotype plate in preference to all other photographic processes? It is quite as sensitive (I think more so) as the most delicate *wet* collodion plate: for sharpness and definition of the result it stands unrivalled, and will retain its exquisite sensitiveness, without deterioration, for twelve hours, or even longer."

Sir John Herschel incidentally alludes to the eclipse in the following passage extracted from a letter to the Editor, dated Collingwood, March 20:—"We got a good sight of the eclipse through cloud in progress and its maximum, but in such brief snatches that I can only say the moon seemed to go over the sun just as a black disk of paper, a little jagged at the edge, goes over a smooth cut white one. Positively no flexure of cusps one way or other. A fine group of spots was passed over. The moon was certainly blacker than the *umbra* of the spots."

At Aberdeen the eclipse was occasionally seen through the clouds; but although Professor Thomson, of King's College, had made arrangements beforehand for observing the various astronomical and meteorological circumstances of the phenomenon, the results were so incomplete in consequence of the unfavourable state of the weather, that he considers their publication in a detailed form would not be attended with any real advantage to science. The following remarks on the meteorological features of the eclipse are contained in a letter to the Editor :—"The eclipse commenced at $11^h\ 45^m\ 29^s$ G. M. T. The barometer exhibited a marked rise from the morning to the afternoon, but this was evidently an effect independent of the obscuration of the solar dise. The rise of temperature in the shade, which would, from the time of day, have been noted till nearly the time of the close of the eclipse, was arrested, the thermometer varying very slightly, if anything marking a decrease. The photometer* (one bulb coloured), which rose from $73\frac{1}{2}°$ at 9 A.M. to 91° about five minutes before the commencement of the eclipse, fell afterwards; but unfortunately cloud and eclipse being mixed up with one another after this, we can only take the numbers to which are appended the words 'cloud passed off.' Thus we have

h m	o	h m	o	
9 30	$80\frac{1}{2}$	11 55	86	
11 15	80	12 0	85	
11 20	81	12 5	71	(after a slight cloud)
11 25	87	12 $34\frac{1}{2}$	35	
11 30	87	12 40	34	
11 35	90	1 9	0	
11 40	91	1 10	3	
		1 12	5	

after which, in spite of cloud, an almost uninterrupted rise."

The effect of cloud is thus shown :

h m	o	
11 45	85	cloud
11 $46\frac{1}{2}$	45	do.
11 50	70	slight do.
11 51	41	cloud
11 55	86	clear

* The instrument, with which the observations were made, is a Leslie's *Photometer*, i. e. a differential thermometer of which one bulb is transparent and the other coloured nearly black; a scale which is attached indicates the difference in level of the fluid in the two branches. The readings are of course of no value, except as a means of comparing the heating power of the sun at different periods. Had the weather during the eclipse been propitious, observations would have been subsequently made on the earliest possible favourable day, so as by comparison to have afforded some estimate of the loss of solar calorific intensity during the eclipse.

To the north of Aberdeen, the weather was generally favourable for viewing the eclipse. At Banff, Elgin, and Inverness, the uneclipsed portion of the sun continued to be beautifully visible during the whole of the time of the occurrence of the phenomenon. A photograph of the solar crescent, as it appeared at the time of greatest obscuration, which had been taken at Banff by Mr. A. Rae, a professional photographer of that town, was exhibited at the meeting of the Society.

Towards the close of the meeting Mr. Carrington addressed some remarks to the members present in reference to the total eclipse of the sun which will be observable in the month of September next on both the west and east coasts of South America. It seemed desirable, in the first place, to assemble the results of observation in the cases of the last four eclipses of which the accounts are the most reliable; and he took leave to exhibit four diagrams (on a scale of 12-inches diameter) of what he concluded, from careful comparison of the principal accounts, to have been the actual appendages to the periphery of the sun.

For that of 1842, July 8, he had compared the accounts of M. Arago, Mr. Airy, Mr. Baily, and Prof. Schumacher: and it appeared to him that the existence of four protuberances was well established at the respective angles from north point (measured easterly) of 89° (with some uncertainty), of 285°, 310°, and 338°. The first bifurcated, of a height of about 2′, and with a base extending over 10°. The second bifurcated, of a height of about 1′·5, with a general slope south-westwards. The third of a height less than 1′, and probably fainter than the rest. The fourth closely resembling the second in tint, form, and slope. The projection of the north pole of rotation about 0°·5 east of north.

For that of 1850, August 7, the results rested solely on the account of M. Kutczycki from Honolulu, given by M. Arago in the *Comptes Rendus* for April 21, 1851. Four principal protuberances were described as seen at the angles from north point of 90° (*due* east), 281°, 312° (uncertain), and 320° (uncertain); together with a low margin of red tint extending from about 265° to 330°. The first of a height of nearly 2′, and form that of a semi-ellipse divided at its minor axis—base equal to semi-major axis. The second bifurcated, and of a height somewhat exceeding 1′. The third detached from the limb, and subdivided into two portions having a resemblance to two arrow-heads, the inner one with its point towards the centre, the outer of double length, with its point turned outwards — greatest height, 2′. The fourth bifurcated and lower. The angular positions of the third and fourth inferred approximately from insufficient description. Projection of north pole of rotation 13°·5 east of north.

For that of 1851, July 28, he had compared eleven of the principal German accounts, of which those of Littrow and Wichmann deserved especial mention, in addition to those given

in the *Memoirs* of this Society, among which those of Mr. Lassell and Mr. Dawes were conspicuous for accuracy and fulness. The photograph obtained at Königsberg, though on a very small scale, was found of material assistance in settling angles. The existence of the following protuberances appeared to be placed beyond doubt. The first at 53° from north point — conical, tapering, height less than 1′; the second at 86°—toothed, height about 1′; the third at 110°— bifurcated, and lower; fourthly, a low faint bank from about 117° to 133°; fifthly, a more conspicuous bank from 145° to 197°, with a principal eminence at about 153°; sixthly, a bank from 220° to 255°, with a toothed peak at about 225° and a terminal bifurcated eminence at 253°; seventhly, the notorious region from 262° to 284°, with its detached mass at about 268°, and the base of the hook-formed protuberance at 283°; eighthly, a bifurcated peak at 314° — height 0′·7; and ninthly, at 320°, a protuberance of a height less than 1′, of the general form of a hook turned towards the north point. The angles observed by Messrs. Swan, Littrow, and Wichmann, and estimated by Mr. Dawes, duly corrected, assign the angle 283° to the base of the principal hooked protuberance, with a liability to an error of not more than 1°, and the Königsberg photograph thence assigns the angles of position of the ninth, first, second, and third protuberances. (Limitations of space prevent the statement of other details and considerations.) Projection of north pole of rotation 9°·5 east of north point.

For the eclipse of 1853, November 30, the accounts of Dr. Moesta, in the *Monthly Notices* and *Gould's Ast. Journal*, are the only available sources. A considerable bank of red matter from 285° to 322°, culminating towards the centre to a height of 1′ or rather more; and two (so described) black protuberances at 335° and 347°, of height less than 1′, are described and delineated in his engraving. Projection of north pole of rotation 16°·5 east of north point.

The angles above given, and which were used in preparing the diagrams exhibited, would be found to reduce all the scattered accounts to satisfactory consistency, and would enable any one to compare their relations with the disks of the sun and moon and with the body of the sun. They were given with reference to the centre of the sun, and were in the diagrams laid off on the periphery of an imaginary lunar disk, concentric and equal to that of the sun.

The first question of interest arising out of these appearances, and on which many opinions were somewhat hastily expressed in 1851, was the degree of connexion between the protuberances and the spots on the disk of the sun. Many observers prematurely inferred a correspondency of position, that the red protuberances were situated immediately over solar spots on the sun's body. The idea proved to be totally unfounded on careful examination; and the assertion of the absence of connexion was not made for the first time on this occasion by Mr. Carrington. In the first

place, it was expressly stated by the Astronomer Royal in 1842, and the fact confirmed by the register of Hofrath Schwabe, that there were no noticeable spots on the sun on the 8th of July. The diagrams of Professor Sestini, in the Washington observations, showed that spots were numerous in September and October, 1850, but did not commence in time to permit a comparison for the 7th of August. Mr. Carrington's registers enabled him to speak definitely with regard to the case of 1853, three dots near the centre of the disk being alone visible on Nov. 30; while a spot of greater size, which came into sight on the following day, was situated on the limb at 120° from N. on the day of the eclipse. The case of 1851 had already received careful examination by Littrow, and deserved it, for the purpose of setting the question at rest. A careful reduction of the observations of Messrs. Littrow and Wichmann, and of Mr. Pogson at the South Villa Observatory, which were in perfect accordance, showed certainly a close agreement in position in one case, that of the elongated spot on the east limb on July 28, 1851, and the protuberance at angle 86° from N. The group of eight small dots towards the west limb were at the time of the eclipse situated between the angles 286° and 290°, and irrespectively of their distance from the limb presented no close agreement of position with that of the great protuberance; and the examination of Mr. Carrington was stated to be in entire conformity with that of Mr. Littrow, and opposed to the idea of their relationship entertained by some at the time, and perhaps even still needing refutation. The banks of red matter observed in the neighbourhood of the sun's south pole were wholly irreconcileable with the known limiting parallels of the spots, and the one instance at 86° east of north must be regarded as fortuitous. The faculæ agreed no better.

In the next place, regarding, as he was disposed to do, the protuberances as matter of a cloudy nature suspended in an atmosphere surrounding the photosphere, it was of importance to see if any trace of its existence could be obtained from its refractive action in support of what had already been concluded to be indications of its absorptive action on light. Mr. Carrington referred to the contents of a paper, which he had prepared on the evidence presented by the solar spots in their motions across the disk, and added that, as the paper would appear in the *Monthly Notices*, he would only say that he believed he had detected an absolute trace of a sufficient atmosphere, although the conclusions were rough and open to future amendment.

Coming next to the eclipse of September, the objects of observation and the requisite means, he had found that in 1851 those observers had furnished the most precise results, whose instruments were equatoreally mounted and (leaving out of consideration the Königsberg heliometer) furnished either with glass-micrometers or interior position-circles. The glass-micrometer was simply a plate of glass in the focus divided into squares like a chessboard, by fine parallel lines at intervals of a minute more or less, but equal,

enabling the observer to make a very rapid and fairly accurate estimation of position and magnitude of anything to be noted. The interior position-circle he concluded to be of the nature of a circular comb, the teeth visible on the corona light. The physical details as described were greatly modified by the size of the instrument; and Mr. Carrington expressed the opinion that the time had gone by for observing solar eclipses with 2-inch object-glasses for any useful purpose. If the reports, which would be obtained of the climate of the two coasts in the beginning of September, should be sufficiently favourable to induce observers to make the voyage, equatoreally mounted telescopes of 4 and 5 inches aperture upwards would be now required to add to our knowledge; and observers must prepare for subdivision of labour, and the accurate and rapid measurement of angles of position and distance. The connexion of the protuberances with the sun would not have received all the demonstration which is desirable till the micrometer should in skilful hands have recorded the observed rate of covering and uncovering by the moon. The angles of position of the corona-streamers would require to be accurately recorded for future inquiry; their nature and relations being still very obscure. Of the red protuberances details of structure and colour of characteristic individuals seen under sufficiently high power would be of more value than imperfect and doubtful outlines of a great number. Their distribution was perhaps sufficiently known already, their nature far less. The observer would probably produce a better result with a fine brush and a pallet of colours than with a metallic pencil. Photography, having succeeded in 1851, would be prepared to lend still more valuable aid in 1858. For his own part, Mr. Carrington would wish to see the method of observing by projection of the image tried, and believed that it would succeed if proper precautions were taken to screen the plate from direct and top light. He exhibited a rude map of the southern continent of America, with the shadow-path laid down, for ocular inspection, and pointed out that the position on the east coast, about 300 miles south-west of Rio, would be rather the more favourably circumstanced, although both stations commanded high ground, and were approachable by well-known routes. As the subject would, no doubt, be resumed, he would confine himself to hoping that at a time when Englishmen made long summer rambles, for no more important object than to return and say that they had reached the summit of some lofty mountain, a sufficient amount of enterprise and intellectual sagacity would not be wanting on an occasion such as the present year would offer for adding to the stock of human knowledge.

A letter has been received by Professor Powell from the Hon. William Stuart, Secretary of the British Legation at the Court of Brazil, promising the most cordial promotion on his part of the wishes of any gentleman who may visit Rio Janeiro for the purpose of observing the eclipse.

Note on the Lunar Eclipse of Feb. 27. By S. C. Whitbread, Esq.

The eclipse of the moon of February 27 was observed by Mr. Whitbread, at his observatory, Cardington, Bedfordshire. In a note to the Editor, he states that about the middle of the eclipse he observed a deep red tinge on the edge of the moon opposite to the portion obscured. When the eclipse had attained its greatest magnitude, he perceived a well-defined line outside the upper part of the moon's limb, which continued visible until the moon had almost entirely emerged from the earth's shadow.

Observation of a Small Star in the Vicinity of Saturn's Ring. By Sir William Keith Murray.

On turning my large equatoreal on *Saturn* last night, I observed, as I thought, *Enceladus* at (5); but, on looking again, about $9^h\ 20^m$, I was surprised to see a brighter point of light either in contact with the ring or barely clear of it (above 5). Unfortunately, the atmosphere was very unfavourable. I

knew it could not be *Mimas*, from its brightness and its position, besides the difficulty of seeing so small a satellite.

I watched the planet at intervals till $11^h\ 30^m$, when the stars were in this position:—

showing it to be a double star.

I cannot say whether there was an occultation by the ring or not, but I certainly did not even suspect the larger star, when I made a diagram of the supposed satellites at $8^h\ 40^m$ and at $9^h\ 30^m$. The larger one could not be overlooked, even in the then unfavourable state of the atmosphere.

I shall be glad to hear that other observers have been more fortunate in seeing this rare occurrence.

I beg to enclose the latitude and longitude of my Observatory, deduced from two points, distant one and two miles, in the Ord-

nance Survey, kindly communicated by Colonel James, and both visible from the Observatory.

Lat. 56° 23′ 24″·9 Long. 3° 53′ 1″·5 W.

The satellites are numbered according to their brightness No. 1 being *Titan*.

Possibly No. 5 may still have been *Enceladus*, though I could not detect any change of position between it and the star.

Ochtertyre, Crieff, April 5, 1858.

Observation of a Small Star in the Vicinity of Saturn's Ring.

By W. Lassell, Esq.

On turning the 20-foot telescope on to *Saturn* at $9^h\ 45^m$ on the 4th instant, I was immediately surprised to observe a pretty bright star so extremely close to the ring that it could not possibly be a satellite. When first seen it appeared as follows :

The star, moreover, had a minute companion, 5″ or 6″ distant north preceding. In the above diagram the satellites observed are designated by the numbers placed over them in the order of their distance from the planet.

The brightest star of the two forming the double, when first seen, at $9^h\ 45^m$ G.M.T., was in the line of a vertical tangent to the preceding limb of the ball, and distant from the outer edge of ring A, the apparent or projected breadths of rings A and B at the nearest point to the star. Overpowered by the brightness of the planet so very close, the star was fainter than either of the satellites 3 or 4 (*Tethys* and *Dione*), though, I believe, if removed to an equal distance with 5 (or *Rhea*), it would be at least as bright. The minute companion of this star appeared a little brighter than 2 (or *Enceladus*). Its distance from the brighter one is rather less than the present distance of *Enceladus* from the ring.

At $10^h\ 10^m$, *Saturn* had left the star behind, and it was then, as in annexed figure, opposite a point half way between the preceding limb and the inner edge of ring B.

At $10^h\ 30^m$, the bright star was opposite the middle point of the breadth of ring C, and is distant from the outer edge of A, the breadth of the three rings at the point nearest the star.

At $10^h\ 50^m$, the star was in the direction of a tangent to the inner edge of ring B, if the planet had not indeed left it somewhat further behind.

As *Saturn* was moving eastward almost exactly in a parallel of declination (very slightly southward), I have little doubt that a couple of hours before the brightest star had been occulted by the ring.

The occultation of a star by *Saturn*, large enough not to be extinguished by the lustre of the planet, is a much more rare phenomenon than might perhaps be supposed, for it has never fallen to my lot to observe it before. The place of the minute double star I had no opportunity to determine; the tabulated place of *Saturn* would, however, of course, give it approximately, and, if necessary, future determination of the place of the star would give the place of *Saturn* if it were required with considerable accuracy.

Bradstones, Sandfield Park, Liverpool, April 6, 1858.*

Extract of a Letter from Mr. Maclear to the Astronomer Royal, dated Royal Observatory, Cape of Good Hope, Dec. 26, 1857.†

"I have D'Arrest's comet of 6·4 years period in tow, which I am working (rather Mann is) with a flat wire micrometer by Simms, attached in a make-shift way to the $8\frac{1}{2}$ feet equatoreal. Unfortunately the line of sight is through the kloof between Table Mountain and the Lion's Head, in the line of the driblets from the Table cap. The object is very faint."

RECENT PUBLICATIONS.

On the Effect of Local Attraction upon the Plumb-line at Stations on the English Arc of the Meridian, between Dunnose and Burleigh Moor; and a method of computing its Amount. By the Rev. John Henry Pratt, M.A., Archdeacon of Calcutta. (*Phil. Trans.*, 1856, vol. 146, Part I., pp. 31–52.)

The author first calculates the ellipticity of the English Arc between Dunnose and Burleigh Moor, without taking account of local attraction. Combining the five subdivisions of the arc two and two, he obtains ten values of the ellipticity, and hence deduces

* The reader is requested to rely rather on the text of the two foregoing papers than on the accompanying woodcuts, the originals of which in both cases were merely rough sketches with the pen.—R. G.

† This is the letter referred to in the Annual Report (see present volume, page 118).

a mean value equal to $-\frac{1}{47\cdot8646}$. Attributing this anomalous result to the effect of local attraction, he proceeds to investigate a formula for calculating its amount at any station. By the application of this formula he finds the deflection of the plumb-line at Burleigh Moor to the south to be 3″·660, and he hence deduces the deflection of the plumb-line at the various stations to the south of Burleigh Moor. In his investigation the author assumes the mean ellipticity of the earth to be $\frac{1}{300\cdot8}$ as determined by the Astronomer Royal.

On the Deflection of the Plumb-line at Arthur's Seat, and the Mean Specific Gravity of the Earth. Communicated by Lieutenant-Colonel James, R.E., F.R.S., &c., Superintendent of the Ordnance Survey. (*Phil. Trans.*, 1856, vol. 146, Part II., pp. 591–606.)

In a preliminary statement Colonel James announces the completion of all the computations relating to the Primary Triangles of the Ordnance Survey, the measurement of the Arcs of Meridian, and the determination of the Dimensions and Figure of the Earth.

The deflection of the plumb-line at Arthur's Seat was found to be 5″·25 to the south; at the Royal Observatory, Edinburgh, it amounted to 5″·63 in the same direction. The observations for determining the mean density of the earth were made with Airy's Zenith-sector, on the top of Arthur's Seat, and on the north and south of that mountain, at about one-third of its altitude above the surrounding country. Two hundred and twenty double observations of stars were taken at each station by Serjeant-Major Steel of the Royal Sappers and Miners. To Capt. Clarke, R.E., was entrusted the reduction of these observations and the computation of the local attraction at the Calton Hill. The paper was also drawn up by the latter. The resulting value of the mean density was found to be $5\cdot316 \pm 054$.

On the Figure, Dimensions, and Mean Specific Gravity of the Earth, as derived from the Ordnance Trigonometrical Survey of Great Britain and Ireland. (*Phil. Trans.*, 1856, vol. 146, Part II., pp. 607–626.)

This paper commences with a historical sketch of the operations connected with the Trigonometrical Survey of the United Kingdom, from its commencement in 1784, down to its completion in the present day. A detailed account of these operations is

stated to be in the press, and will shortly be published. The paper to which we now refer was drawn up by Capt. Clarke, R.E., and may be considered as an abridgment of that account.

In the course of the Survey seven base-lines were measured; five with Ramsden's steel chain, and the remaining two with General Colby's compensation-bars. The bases measured with Ramsden's steel-chain were those of Hounslow Heath (1791), Salisbury Plain (1794), Misterton Carr (1801), Rhuddlan Marsh (1806), and Belhelvie (1816). The bases measured with the compensation-bars were those of Lough Foyle (1826–7) and Salisbury Plain (1849). The latter was a remeasurement of the original base-line. It was found that the new measurement exceeded the old by a foot. The linear scale of the triangulation is made to depend on the bases measured with the compensation-bars at Lough Foyle and on Salisbury Plain. The discrepancy between the measured and calculated lengths of these bases is about five inches. This discrepancy is divided so that each of the two bases shall exhibit an error proportional to the square root of its length. The comparison of all the bases is then as follows :—

Date.	Base.	Measured Length in terms of Ordnance Survey.	Length obtained by Triangulation.	Difference.
		Feet.	Feet.	Feet.
1791	Hounslow Heath	27406·190	27406·363	+0·173
1794	Salisbury Plain	36576·830	36577·656	+0·826
1801	Misterton Carr	26344·060	26343·869	−0·191
1806	Rhuddlan Marsh	24516·000	24517·596	+1·596
1817	Belhelvie	26517·530	26517·770	+0·240
1827	Lough Foyle	41640·887	41641·103	+0·216
1849	Salisbury Plain	36577·858	36577·656	−0·202

Approximate values of the deflections at the principal stations of the survey are obtained by comparing the observed latitudes with those computed from Airy's elements of the earth's figure. The results of the survey are then employed in combination with all the most trustworthy arcs of the meridian hitherto measured on the earth's surface, with the view of obtaining a correction of the elements of the earth's figure. The materials selected for this purpose are those relating to the ten arcs of the meridian employed by Bessel in a similar investigation, except that the most recent data of the English and Indian Arcs are substituted for the original values. The equations of condition are then formed and treated by the method of least squares.

The following are the definitive results of the investigation :—

1. The four bases of verification, when their measured lengths are compared with their lengths as calculated from a mean of the Lough Foyle and Salisbury Plain bases, show the following discrepancies, expressed in feet :—

Hounslow.	Misterton Carr.	Rhuddlan Marsh.	Belhelvie.
+0·173	−0·191	+1·596	+0·240

2. The elements of the spheroid most nearly representing the surface of Great Britain are:—

	Feet.		Miles.
Equatoreal Semidiameter	20926249	=	3963·305
Polar Semidiameter	20856337	=	3950·064

whence ellipticity $= \frac{1}{299{\cdot}33}$

3. The elements of the spheroid most nearly representing the whole of the measured arcs which form the groundwork of the investigation are:—

	Feet.		Miles.
Equatoreal Semidiameter	20924933	=	3963·057
Polar Semidiameter	20854731	=	3949·760

whence ellipticity $= \frac{1}{298{\cdot}07}$

Account of Pendulum Experiments undertaken in the Harton Colliery for the purpose of determining the Mean Density of the Earth, (with a Supplement). By G. B. Airy, Esq., Astronomer Royal. (*Phil. Trans.*, 1856, vol. 146, Part I., pp. 297–355.)

The researches of which an account is given in this paper have been already alluded to in the *Monthly Notices*. The mean density of the earth was found to be $6{\cdot}566 \pm {\cdot}0182$. In the Supplement to his paper, Mr. Airy investigates the effect depending on the result of fresh experiments instituted for ascertaining the mean difference of the temperature of the pendulums, and hence determines the mean density of the earth to be 6·623.

On the Problem of Three Bodies. By the Rev. J. Challis, M.A., F.R.S., F.R.A.S., Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge. (*Phil. Trans.*, 1856, vol. 146, Part II., pp. 523–545.)

The author commences with some preliminary remarks on the difficulty attending the more obvious method of treating the problem of three bodies, arising from the circumstance that terms appear in the solution which increase indefinitely with the time, and are consequently inapplicable to the observed motion of any of the heavenly bodies. Although this difficulty is evaded by having recourse to an assumption which is justified by observation, still it appeared to the author very desirable to obtain the true form of development by a purely analytical process. Accordingly, he proceeds to explain a method which he had devised for this purpose, by which the forms of the expressions for the radius vector, longitude and latitude, and both the secular and

periodical inequalities are evolved by the analysis alone, and which is applicable as well to the lunar as the planetary motions.

The solution is derived from the following three differential equations, in which the letters have the signification usually attached to them in the planetary theory :—

$$\frac{dr^2}{dt^2} + \frac{h^2}{r^2} - \frac{2\mu}{r} + C = 2\int \left\{ \frac{d^2\theta}{dt^2} \int \frac{dR}{d\theta} . dt - \frac{dR}{dr} . \frac{dr}{dt} \right\} dt$$

$$\frac{d\theta}{dt} = \frac{h}{r^2} - \frac{1}{r^2} \int \frac{dR}{d\theta} . dt$$

$$\frac{d^2z}{dt^2} + \frac{\mu z}{r^3} + \frac{dR}{dz} = 0$$

The elliptical values of r and θ being substituted in the right-hand side of the first equation, an approximate value of the disturbed co-ordinate r in terms of t is found by integration; and the substitution of the result in the terms of the second and third equations which do not contain the disturbing force, gives the corresponding values of θ and z. In this way the values of the co-ordinates r, θ, and z, may be found to the first power of the disturbing force and to any power of the eccentricity. No terms containing *ent* as a factor enter into the expression for either co-ordinates, but there are terms involving *e'nt* which the author shows to admit of being transformed into periodic series depending on the secular variations of the excentricity and perihelion. The author has illustrated the practicability of his method by the actual solution of the equation for r and θ, and he purposes developing his researches on a future occasion.

The Practice of Navigation and Nautical Astronomy. By Henry Raper, Lieut. R.N. &c. Sixth Edition. 8vo. London, 1857.

This standard work is too well known to require any notice of its contents. It is to be hoped that the author of so valuable a guide to the navigator will ere long recover from the protracted illness under which he has been labouring, and which has caused such deep and general regret.

Récherches sur les Mouvements de Neptune suivies des Tables de cette Planète. Par M. Kowalski, Professeur d'Astronomie à l'Université de Kasan. Kasan, 8vo. 1855.

This publication consists essentially of two parts. In the first part, the author investigates the corrections to be applied to the elements of the planet, taking into account the perturbations produced by *Jupiter*, *Saturn*, and *Uranus*. The materials which form the basis of this discussion consist of the early observation of the planet by Lalande in 1795, and all the accessible modern

observations extending from 1846 to the close of 1853. The corrections applicable to Walker's elements of the planet obtained by the author are very small—a circumstance which redounds to the merits of the American astronomer, who succeeded in determining the orbit of the planet with such precision from observations extending over a very small arc. The following are the definitive values of the elements obtained by the author as the result of his researches:

Mean motion	7873″·993
Mean distance	30·03386
Excentricity	0·0091736
Epoch	334° 36′ 29″·78
Longitude of the perihelion ...	50 16 39 ·08
Longitude of the node	130 7 45 ·30
Inclination	1 47 0 ·89

These elements refer to the mean equinox of 1850·0.

Tables of the planet founded on the foregoing corrected elements constitute the second part of this publication. In Table I. the author gives the heliocentric longitude and latitude and the logarithm of the radius vector for every thirty days throughout the period extending from 1846 to 1880, with columns of differences for interpolation. Table II. contains the values of certain of the subsidiary quantities depending on the heliocentric rectangular co-ordinates of the planet, by means of which, in connexion with the sun's rectangular co-ordinates, given in the *Nautical Almanac*, the geocentric right ascension, declination, and distance of the planet, may be found for every thirty days from 1850·0 to 1880·0. These tables are followed by an ephemeris of the planet, extending from 1846 to 1855.

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*Nachweis des Vorkommens von Sternen aus den Argelander'schen nördlichen Zonen in anderen Quellen.** Von W. Oeltzen.

In a former communication M. Oeltzen had given a catalogue of all the stars contained in Argelander's zones, the positions of which had been also determined by other observers. He was then unacquainted with Fedorenko's Catalogue (*Monthly Notices*, vol. xvi. p. 133), comprising the stars which had been observed by Lalande and his assistants, but which are not to be found in the *Histoire Céleste*. In the present paper he has given his previous communication a more complete form by giving a list of all the stars in Argelander's zones which are to be found in other catalogues, including those of Fedorenko, Johnson, and Schwerd, which he had previously omitted, and the stars in vol. i. of the *Dorpat Observations*.

* Sizungsberichte der Kaiserlichen Akademie der Wissenschaften. XXI. Band, I. Heft. Wien, 1856.

*Resultate aus der Vergleichung des Sternkatalogs von Fedorenko mit anderen Quellen.** Von W. Oeltzen.

In this paper M. Oeltzen has given a list of the stars in Fedorenko's catalogue, which are not to be found in Argelander's zones, but which are contained in other star catalogues. He has also instituted a comparison of the positions of the individual stars in Fedorenko's catalogue, with the more recent determinations of Argelander and other observers, and has thus succeeded in detecting a great number of errors, with which the earlier observations of Lalande and his associates were affected.

The results of his researches have indicated considerable proper motions in the case of many stars; in others the existence of such a motion has been established with more or less probability.

Astronomisches Jahrbuch für 1860.

This volume of the Berlin Ephemeris contains, in addition to the usual matter, a valuable paper by Professor Encke on the development of a function in terms of the sines and cosines of multiples of a given angle.† In the *Annales de l'Observatoire Impérial de Paris*, tome i. p. 384, M. Le Verrier has given a method for computing, by a process of interpolation, the numerical values of the coefficients of the individual terms in such a series. In his researches, however, for determining these values, the author has employed the imaginary expressions for the sine and cosine. The object of Professor Encke's paper is to show that the principle of the same method may be successfully applied without having recourse to any other than the ordinary forms of analysis.

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* Sitzungberichte der Kaiserlichen Akademie der Wissenschaften. XXII Band, III. Heft. Wien, 1857.

† Uber die Entwickelung einer Funktion in eine periodische Reihe nach Herrn Le Verrier's Vorsclag.

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An account of observations of the eclipse by Mr. De La Rue, which was too late for the present Notice, and a few other short papers on the same subject, will be inserted in the next Number of this Journal.

ERRATA.

Vol. XVII., last line, p. 255, after the word instrument, *read*— which is somewhat rickety, and should in my opinion be rejected, a better one by Dolland being now generally employed.
Vol. XVIII., p. 96, line 4 from the bottom, *for* 1832 *read* 1829.

Erratum in Hansen's Lunar Tables.

Page 299, Value of ω opposite to -300, *for* 298·44323, *read* 289·44323.

Erratum in the Astronomische Nachrichten, No. 1137, page 139–140,

Observations of the Solar Eclipse of 1858, March 15, at the Observatory of Padua, End of the Eclipse observed by Trettenero, *for* $3^h\ 11^m\ 59^s{\cdot}3$, *read* $3^h\ 11^m\ 49^s{\cdot}3$.

CONTENTS.

Page

Fellow elected 165

Elements of Comet II. 1858, by Dr. Winnecke ... ... ib.

Discovery of a New Planet, by M. Luther 166

Observations of Small Planets at the Royal Observatory ... ... ib.

Extract of a Letter from Capt. Jacob to Sir W. Keith Murray on the Colours of B and C of *γ Andromedæ* 169

On the Law of Contraction of the Nebulosity of Encke's Comet, by Mr. Drach ... ... ib.

On the Evidence which the Observed Motions of the Solar Spots offer for the Existence of an Atmosphere surrounding the Sun, by Mr. Carrington ... ... ib.

On Col. James's Geometrical Projection of the Sphere, and on the Stereographic Projection, by the Astronomer Royal 178

Observations of the Annular Solar Eclipse of March 14–15, 1858:—

Mr. Weston,	Mr. Glaisher,	
Messrs. W. and J. Simms,	Mr. Sopwith,	
Mr. Slatter,	Dr. Bowerbank,	
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Admiral W. H. Smyth,	Sir W. Keith Murray,	
Mr. M'Laren,	Mr. Williams,	
Mr. Stuart,	Sir John Herschel,	
Mr. Wilkinson,	Professor Thomson,	181–213

On the Total Eclipse of the Sun observable in September next on the West and East Coasts of South America, by Mr. Carrington 213

Note on the Lunar Eclipse of Feb. 27, by Mr. Whitbread 217

Observation of a Small Star in the Vicinity of *Saturn's* Ring, by Sir William Keith Murray and Mr. Lassell ... ... ib.

Extract from a Letter of Mr. Maclear to the Astronomer Royal 219

Recent Publications:—

On the Effect of Local Attraction upon the Plumb-line at Stations on the English Arc of the Meridian between Dunnose and Burleigh Moor, by Archdeacon Pratt ... ... ib.

On the Deflection of the Plumb-line at Arthur's Seat, and the Mean Specific Gravity of the Earth 220

On the Figure, Dimensions, and Mean Specific Gravity of the Earth ib.

Account of Pendulum Experiments undertaken in the Harton Colliery for the purpose of determining the Mean Density of the Earth (with Supplement), by the Astronomer Royal 222

On the Problem of Three Bodies, by Prof. Challis ... ... ib.

The Practice of Navigation and Nautical Astronomy, by Lieut. Raper 223

Recherches sur les Mouvements de *Neptune* suivies des Tables de cette Planète, by Prof. Kowalski... ... ... ib.

Nachweis des Vorkommens von Sternen aus den Argelander'schen nördlichen Zonen in anderen Quellen, by M. Oeltzen 224

Resultate aus der Vergleichung des Sternkatalogs von Fedorenko mit anderen Quellen, by M. Oeltzen 225

Astronomisches Jahrbuch für 1860 ... ... ib.

List of Institutions and Individuals entitled by the Authority of the Council to receive the *Monthly Notices* as they are published ... ... ib.

Miscellaneous 227

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